ANNUAL REPORT

OF THE

NATIONAL BOARD OF HEALTH.

1880.

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THE NATIONAL BOARD OF HEALTH.

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TABLE OF CONTENTS.

INDEX TO ILLUSTRATIONS.

REPORT OF HAVANA COMMISSION.

GAUGING OF SEWERS.

SUSPENDED PARTICLES IN THE AIR.

CLIMATE AND DISEASES.

REPORT

OF THE

NATIONAL BOARD OF HEALTH.*

NATIONAL BOARD OF HEALTH,
Washington, D. C., January 1, 1881.

Hon. JOHN SHERMAN,
Secretary of the Treasury:

SIR: The National Board of Health, in making its second annual report, feels that it has a right to congratulate the country upon the general results of its labors since it went into operation in April, 1879. These results, as will be more particularly shown in the sequel, have reference either to the investigation of the causes of disease by means of scientific experiments and by sanitary surveys of places more than usually unhealthy, or likely to become so, or to measures which have for their end the prevention of the introduction of contagious and infectious diseases into the United States from foreign countries, or from one State into another.

It is hoped that before many years have passed the people will have become so educated to the idea of public sanitation that not only every State and Territory but every township will have its own board of health, in the assured conviction that it is far better to provide for the prevention than for the cure of disease, especially for those pestilential diseases of indigenous and local origin, for which, in all probability, a preventive remedy may be found in careful and habitual attention to local sanitation, while other machinery must be invoked to deal with those more pervasive pestilences which, introduced from abroad as an incident of commerce, may overrun and devastate vast territories, and which, in order to be checked, require the intervention of the strong arm of the general government in the exercise of its powers to regulate commerce with foreign countries and between the several States. Of these two functions of the National Board of Health, as determined respectively by the constituting act approved March 3, 1879, and by the act to "prevent the introduction of contagious and infectious diseases into the United States," approved June 2, 1879, the former is recommended to the support of the national legislature for the two-fold reason that the resulting benefits will not be the exclusive possession of any one section of the country, but will apply equally to all, and that the cost of conducting such investigations is beyond the means of private individuals or the separate States.

In this connection it is pertinent to allude to the great impulse given to the progress of preventive medicine by the special scientific investigations conducted by experts appointed for the purpose by the local

*This is for the fourth quarter of 1880, and includes a summary of the operations of the Board for the year ending December 31, 1880.

government board of England, and published in connection with the reports of the medical officer of the Privy Council. In regard to the value of these scientific investigations in their relation to the increase of our resources for the prevention and cure of disease, there can be but one opinion among those who are competent to judge. One of the most notable and beneficent improvements in modern surgery, the practice of the antiseptic treatment of wounds, is believed to have reduced the mortality of many of the graver surgical operations by at least 50 per cent.; and this remarkable result which, with equal truth, may be affirmed with respect to the death-rate of accidental wounds, is justly accredited to the investigations of a few zealous votaries of science on the life-history of certain microscopic organisms, investigations which, when first undertaken, were seemingly as remote from any probability of being immediately applicable to purposes of practical utility. Many others of equal significance might readily be cited to illustrate the bearing of scientific researches on the enlargement of our means of preventing and of curing disease. In an earnest appeal to the privy council to continue these investigations it was urged by their distinguished medical officer that where research, if it is to succeed, requires systematic and continuous labor extending over long periods of time—labor not only inconducive to immediate pecuniary profits, but, perhaps, involving much cost—it can hardly be expected that the study, however great its eventual importance, will be adequately cultivated by private investigators.

To set on foot and direct such investigations by means of competent experts appointed and paid by the National Board of Health, to obtain information upon all matters affecting the public health, to advise the several departments of the government, the executives of the several States, and the Commissioners of the District of Columbia, on all questions submitted by them, or whenever in the opinion of the Board such advice may tend to the preservation and improvement of the public health, were the obligations imposed on this Board by the act of March 3, 1879.

In the discharge of these duties the Board has since the date of its organization set on foot the following investigations and inquiries, a few of which are still in progress, the others having been finally completed. Most of them have been noticed in former reports, with appropriate explanations as to their end and methods, which it would be unnecessary to repeat at this time.

I. The collection of information and advice from the principal sanitary organizations and sanitarians of the United States as to the best plan for a national public health organization, including the subject of quarantine, both maritime and inland, and the relations which should exist between State and local systems of quarantine, and a national quarantine system. The information thus collected and the reports of the National Academy of Sciences which had been required to co-operate with the Board in deducing conclusions from such information were embodied in the first annual report of this Board.

II. The investigation of yellow fever in the island of Cuba by a commission of experts consisting of Dr. S. E. Chaillé and Col. T. S. Hardie, C. E., of New Orleans, Dr. G. M. Sternberg, U. S. A., and Dr. John Guitérás, of Philadelphia. The final report of this commission has been received and is appended hereto. (See Appendix B.)

III. The collection of the sanitary laws of the United States and of the several States, including both the statutes and the decisions of the several courts on all questions involving the public health. A large

part of this work—that, namely, relating to judicial decisions by R. C. Lincoln, esq., of Boston—has been completed, the remaining part being in progress under the direction of E. B. Smith, esq., of the law department of the United States Government.

IV. An investigation as to the best method of determining the amount and character of organic matter in the air has been completed by Prof. Ira Remsen, of the Johns Hopkins University, of Baltimore, whose preliminary report on the same subject has heretofore been transmitted to Congress in connection with the first annual report of this Board. The final report is hereto appended, marked C.

V. An investigation as to the effects of disinfecting agents upon the causes of the infectious diseases was assigned, under the general direction of Dr. C. F. Folsom, to Dr. W. S. Bigelow, of Boston, who would be assisted by Dr. H. P. Bowditch, professor of physiology, and Dr. Wood, professor of chemistry, in Harvard University. No report has yet been received from these gentlemen; but it is understood that this very important investigation has been commenced, and is now in progress. During the past year a series of experiments designed to test the value of certain gaseous and volatile disinfectants was made by Dr. George M. Sternberg, U. S. A.

VI. An investigation as to the composition and merits of the various patent disinfectants, by Prof. C. F. Chandler, of Columbia College, New York, president of the board of health of the city of New York, assisted by Elwyn Waller, Ph. D.

VII. An investigation into the adulterations of food in the United States, by Prof. R. M. Kedzie, M. D., president of the State board of health of Michigan, and by Prof. Lewis Diehl, of Louisville, Ky., as to the adulterations of drugs. A later and more detailed report, by Dr. Charles Smart, on adulterations of food recently completed is appended hereto, marked Appendix E.

VIII. A preliminary inquiry as to the communicable diseases of animals, by Prof. James Law, of Cornell University, Ithaca, N. Y., and a report on the same subject, by Dr. T. S. Verdi, a member of this Board, have been heretofore transmitted to Congress as an appendix to the first annual report of the Board.

IX. An investigation of the flow of sewers in relation to their sizes and gradients, by Col. George E. Waring, jr., of Newport, R. I., whose final report is hereto appended, marked F, a preliminary report having been heretofore transmitted to Congress.

X. A report by Dr. Elisha Harris, of New York, upon diphtheria, as it occurred in Northern Vermont.

XI. An investigation by Prof. Raphael Pumpelly, of the United States Geological Survey, aided by Prof. George A. Smyth, upon the influence of various soils upon sanitation, which is still in progress, and promises to yield results of great scientific interest and practical sanitary value. Very recently the Board has authorized Dr. George M. Sternberg, U. S. A., to assist in this investigation with reference to its biological relations.

XII. An investigation by Drs. H. C. Wood and H. F. Formad, of Philadelphia, as to the effects of inoculating lower animals with diphtheritic exudation. (See Appendix G.) Within the past few weeks Dr. Wood has been authorized to continue his researches on this most important subject.

XIII. Researches by Dr. G. M. Sternberg, U. S. A., upon suspended particles in the air of places liable to infection, which were commenced in Havana and have been renewed in New Orleans. These researches include an investigation upon organized particles from swamps and other

malarious localities, with the view of testing the accuracy of the observations of Klebs and Tomassi-Crudeli, and others, on the existence of spores alleged to be the producing cause of malarial fevers. (Appendix H.)

XIV. A report by Dr. J. J. Woodward, U. S. A., on the Pathological Histology of Yellow Fever, is hereto annexed, marked I.

XV. A report by Professor Abbe, of the Signal Service Bureau, on the possible relations between meteorological phenomena and vital statistics, and especially on the graphical methods of representing such data, which report, with the accompanying illustrative diagrams and charts, will be found in Appendix K.

XVI. An investigation by Col. G. E. Waring, jr., of Newport, R. I., on the influence of the water-seal of traps of different kinds of currents of water passing through them or through the pipes into which they deliver, under a variety of conditions, covering ventilation, copious or partial, and induced currents arising from the passage of water over the branches of different form and arrangement, including experiments with regard to siphoning and the best manner to secure an adequate flush for water-closets, drains, &c.

XVII. An investigation by Prof. Ira Remsen, of the Johns Hopkins University, Baltimore, as to the amount of carbonic oxide in furnace-heated rooms.

XVIII. An investigation under the direction and supervision of Prof. J. W. Mallet, of the University of Virginia, on the best method of determining the amount of organic matter in potable water, and its effect on the health of persons who drink such water. This work will involve the co-operation of three distinct analysts, each employing a different method from the rest.

XIX. The history of quarantine in the United States, exhibiting the occasions which give rise to quarantine legislation, or attempts at such legislation by States or by the general government, prepared by Dr. Stephen Smith, a member of the Board.

SANITARY SURVEYS.

The following sanitary surveys have been conducted under the auspices of the Board:

I. A sanitary survey of the eastern coast of New Jersey bordering on New York Harbor, carried on with the aid of this Board, under the direction of the State board of health of New Jersey.

II. A sanitary survey of the city of Memphis, Tenn., under the direction of a special committee of this Board, of which Dr. J. S. Billings was the chairman. The final report of this committee, marked L, is hereto appended. In connection with this survey Dr. Charles Smart, U. S. A., has furnished a full report on the condition of the water supply of Memphis, and also of certain smaller towns in Mississippi, which is appended to the report on the sanitary survey.

III. A report by Dr. Charles Smart on the water supply of Mobile and New Orleans, together with a report on water analysis in general. (See Appendix M.)

IV. A sanitary survey of selected portions of Baltimore City was undertaken by this Board, in compliance with the request of the city council, and Dr. C. W. Chancellor, secretary of the State board of health, was appointed a special sanitary inspector to conduct the work. His report and the correspondence which preceded and followed the work are appended hereto, marked N.

VITAL STATISTICS AND NOMENCLATURE OF DISEASES.

In the quarterly report of this Board for the quarter ending June 30, 1880, reference was made to a conference held in Washington on the 6th and 7th of May, to which the registrars of vital statistics of the different States and municipalities, and all persons interested in the subject, had been invited. The report of the proceedings of the conference, as published in Supplement No. 5 to the BULLETIN, was appended to the said quarterly report. At a subsequent date the committee appointed by the conference to consider the best method of tabulating mortality statistics made a report on that subject, a copy of which is hereto annexed, marked O.

The same committee having been charged with the duty of conferring with the committee of the Royal College of Physicians in London, engaged in the work of revising the standard nomenclature of diseases, and one of its members, Dr. Charles F. Folsom, secretary of the State board of health of Massachusetts, being then about to sail for Europe, the Board availed itself of the opportunity to enable the committee, at a very trifling expense, to confer with said authorities with reference to obtaining a uniform system of nomenclature for Great Britain and her colonies and for this country. The report by Dr. Folsom of the result of his conference with the committee of the Royal College of Physicians is hereto annexed, marked P.

MARITIME QUARANTINE.

A few weeks after the organization of the Board under the constituting act of March 3, 1879, new duties were assigned to it by the quarantine act approved June 2, 1879, entitled "An act to prevent the introduction of contagious and infectious diseases into the United States," and the sum of $500,000 was appropriated to meet the expenses to be incurred in carrying out its provisions.

During the whole of the ensuing summer the efforts of the Board were directed to the end of stamping out existing outbreaks of yellow fever which had already been introduced into the country; but as soon as the pressure of this exigency had ceased the Board solicited an expression of the opinion of eminent legal authorities as to the measures by which it might lawfully and efficiently execute the provisions of an act which had for its main object the prevention of the introduction of contagious and infectious diseases into the United States from foreign countries and from one State to another. In conformity with the general tenor of the opinions thus gathered the Board felt it to be its duty to devise some means whereby its aid could be extended to State and municipal boards of health in such a manner as would establish a reasonably satisfactory system of quarantine police for all of the ports through which infectious diseases and especially yellow fever were likely to find entrance into the United States, when the local authorities were unable without this aid to provide such sanitary safeguards for their own ports and the surrounding country.

The entire fund at its disposal would not have sufficed to establish the most moderately equipped quarantine stations at one-half of the numerous exposed ports on the South Atlantic and Gulf coasts. These ports being within the yellow-fever zone and maintaining close commercial relations with the ports of Cuba and some other tropical countries in which that fever has become permanently established, are constantly exposed to the risk of importing and then of disseminating the infection.

But even if this difficulty had not existed there was another equally embarrassing. The act of June 2, 1879, by its third section authorizes the National Board of Health to aid State and municipal boards of health "as far as it lawfully may" in the execution and enforcement of their quarantine rules and regulations. The limitation precluded the donation of the public funds to the local authorities to be used in the construction of quarantine buildings unless both the buildings and the land they occupy were made the property of the United States, in conformity with the provisions of section 355 of the Revised Statutes. When the attention of the patrons of the bill was called to this fact, and it was represented that the law would prove nugatory as to the attainment of its main object, that of preventing the importation of infectious disease from abroad, unless the funds could be applied to the construction of hospitals, lazarettos, wharves, &c., a supplementary act was introduced, and having passed both houses of Congress was approved by the President, July 2, just a month after the passage of the original act. This amendment provides (sec. 6) that "the Board of Health shall have power, when they may deem it necessary, with the consent and approval of the Secretary of the Treasury, as a means of preventing the importation of contagious or infectious diseases into the United States, or into one State from another, to erect temporary quarantine buildings, and to acquire on behalf of the United States titles to real estate for that purpose, or to rent houses, if there be any suitable, at such points or places as are named in such section."

It will be observed that this provision, so far from releasing the Board from the prohibition implied by the terms of section 355 of the Revised Statutes against the application of the public money to the construction of buildings not the property of the United States, rather enforces the obligation by requiring the Board to acquire titles to real estate as a condition of the erection of temporary quarantine buildings. Relying upon this construction of the law and fortified by the concurrence of the First Comptroller of the Treasury Department it was considered expedient to establish under the auspices of the Board a few fully equipped quarantine stations so located as to avail for the protection of all the exposed ports on the South Atlantic and Gulf coasts. It was believed that this would be perfectly practicable, provided the State or local authorities would require that all *infected* vessels should report to one of these national quarantine stations for inspection and treatment before attempting to enter their ports of destination. Any vessel attempting to enter any port of the United States in violation of this requirement of the State authorities would then incur all the penalties prescribed by the first section of the act approved June 2, 1879, as well as such other penalties as the local authorities may be authorized, by the State or municipal legislation, to enforce.

These stations were thus proposed to be established and conducted in aid of State or municipal boards with the view of preventing the importation of infectious disease into the United States, and in every instance an earnest solicitation on the part of these authorities for the establishment of the stations in question, with a declaration of their inability without such aid to furnish adequate protection for themselves and for the country at large, preceded any action in that direction on the part of this Board. When action was taken, the Board believed that it was carrying out the wishes of the national legislature as expressed in the act of June 2, 1879, and knew that it was in complete conformity with the construction put upon that act by the highest legal authority of the government.

Inasmuch, however, as Congress failed to make the full appropriation which was estimated to be necessary for the efficient execution of the law, the Board withheld any further application of its funds to the construction of buildings, substituting therefor temporary and imperfect arrangements at the quarantine station in Sapelo Sound, off the coast of Georgia, and at Hampton Roads, in Virginia, and suspending all action in regard to proposed disbursements at the Charleston quarantine. It was assumed in the debate in Congress on this subject that the amount of the prospective cost of these improvements, as stated in the estimates furnished by the Board, had actually been expended, and this assumption was the ground of much unfavorable criticism of the alleged extravagance of the Board. But although it was the intention of the Board to make contracts for the three stations, accidental circumstances, which have been explained in the quarterly reports, hereto appended (Appendix A), had precluded their complete consummation at the date of the act of Congress except in the single case of the Ship Island station, off the coast of Mississippi, the works at Sapelo Sound not having proceeded to the extent of the actual construction of the buildings.

In the mean time earnest applications have been addressed to this Board by the health authorities of many of the ports on the South Atlantic sea-board, from Fernandina to Norfolk, soliciting the establishment and equipment of the suspended stations, and representing their utter inability without aid from the general government to provide fully-equipped stations at their respective ports.

COST OF THE PROPOSED QUARANTINE STATIONS.

Ship Island station.

This station, for which the contracts had been signed and the work nearly completed before the close of the last session of Congress, has been constructed at a total cost, to the 31st December, 1880, of $30,047.37, which includes the purchase of an excellent seaworthy steam-tug and other boats, the construction of wharves, warehouse, hospital, quarters for persons not sick but under observation as having been on board infected vessels, and a small building for the medical officer. These structures are temporary in the sense of being built of wood in the most economical style, but are substantial and well adapted to their uses. The cost of maintenance to December 31 was $11,455.90. It is scarcely possible to overrate the value of this station as a means of protecting the public health of the Mississippi coast and of the entire Mississippi Valley if the sanitary authorities of the State of Louisiana would co-operate with the National Board of Health in the practical measures necessary to secure the full benefits for which it may be made available.

Sapelo Sound station.

At this station the purchase of boats and dredging of the channel as preparatory to the construction of wharves had been commenced prior to the date of the appropriation made by Congress for the fiscal year ending June 30, 1881. The total amount expended at that station during the past six months, including dredging, purchase of boats and hospital tents, and cost of maintenance, was $11,219.01. The completion of the equipment of this very important station is considered by the Board to be indispensably necessary for the attainment of the ends of the law. It is respectfully submitted that this may be accomplished

at an expense which is insignificant in proportion to the extent of territory which will be protected. The sanitary authorities of all the ports between Savannah and Fernandina, inclusive, ports particularly exposed to the risks of infection by reason of their proximity to the West Indian foci of yellow fever, are pledged to avail themselves of the proposed quarantine.

Hampton Roads station.

In the quarterly report for the quarter ending March 31, extracts from which are cited in Appendix A, reference is made to the fact that operations at the proposed station in Hampton Roads were necessarily suspended by reason of the failure to obtain a title to the ground with cession of jurisdiction from the legislature of Virginia. A bill to that effect passed both houses of the legislature without opposition, but it reached the governor too late for his examination and approval before the adjournment of the legislature. This Board considered that it would be hazardous to leave so important a point without any means of protection, and purchased a substantial barge, which was equipped as a floating hospital, to be moored in the Roads during the season of danger. The total cost of the barge and its equipment and maintenance of same has been $6,369.91.

It should be borne in mind that this large and commodious harbor is resorted to as a place of refuge for both domestic and foreign shipping bound to other and often distant ports, and driven in by stress of weather, or not unfrequently by the disability of the crew from some infectious disease. Numerous instances might be cited in which the latter condition was the inducing cause for which foreign vessels dangerously infected have put into the Roads for anchorage, but found no means provided for isolating and appropriately treating the sick. It is needless to say that there was more or less danger of the spreading of the disease to other shipping at anchor in the harbor.

Station on the coast of Texas.

In the quarterly report for the quarter ending March 31, 1880, it was stated that the authorities of Texas had made an application to this Board to establish a quarantine station in Galveston harbor, and the opinion was then expressed that it was highly important to establish at least one station for the extended coast of Texas. The application has been recently renewed by the health authorities of Galveston, and the Board has accordingly submitted an estimate of the cost of construction and maintenance. Further information on this subject will be found in the appended quarterly report of this Board for the quarter ending September 30, 1880. (See Appendix A.)

CONGRESSIONAL INQUIRY ON THE NECESSITY OF A NATIONAL QUARANTINE FOR THE ATLANTIC AND GULF COASTS.

In connection with the general question of the policy of establishing a limited number of quarantine stations to be conducted under the direction of the National Board of Health, it is considered pertinent and appropriate to refer to a joint resolution of Congress, approved June 6, 1872, providing "for a more effective system of quarantine on the Southern and Gulf coasts," by which the Secretary of War was directed to detail one or more medical officers of the Regular Army to visit each town and port on the coast of the Gulf of Mexico and the Atlantic coast, liable to invasion of yellow fever, and to inquire whether any system of quarantine

is likely to be effective in preventing invasions of yellow fever, and, if so, what system will least interfere with the interests of commerce at said ports. Dr. Harvey E. Brown, then assistant surgeon of the United States Army, was detailed for this duty, which he discharged with signal ability, announcing his observations and conclusions in a report of great interest and value. The propositions in which he formulated the results of his exhaustive investigations, together with letters from prominent quarantine officers of Southern ports, indorsing his views, are cited in Appendix Q.

By the act approved June 2, 1879, "to prevent the introduction of contagious and infectious diseases into the United States," &c., Congress, in conformity with the spirit of the traditional policy of the government to concede to the individual States the right to frame their own health laws and to execute them within their respective territorial limits, authorized the National Board of Health to co-operate with and, as far as it lawfully may, to aid the State boards in the execution and enforcement of their rules and regulations to prevent the introduction of contagious and infectious diseases into the United States from foreign countries and from one State into another, thus indicating the views of the legislative department of the government as to the relations which should subsist between State and local quarantines on the one hand and a national system of quarantine on the other, with the reserve of power on the part of the general government to intervene by means of the measures specified in section 3 of the act in question for the efficient protection of the public health when the local uthorities refuse or fail to make adequate provision for preventing the introduction of infection from abroad. This system, which substitutes a plan of co-operation with State and municipal boards of health under direction of the National Board in lieu of giving to the latter exclusive jurisdiction over maritime and inter-State quarantine, has been in very successful operation in most of the Southern ports during the past year, and has enabled the National Board to regulate its disbursements with reference to quarantine in proportion to the special exigencies of the public health at different ports, without making distinctions which would be in contravention of the principle of the uniformity of the regulations of commerce for all the ports.

It is greatly to be regretted that the State board of health of Louisiana has hitherto rejected the offer of this Board to provide a safe and convenient refuge at the Ship Island quarantine for infected vessels bound to New Orleans, although it was distinctly explained that no other than *infected* vessels need to be diverted from their usual course, and that as the number of such vessels was small the annual revenues of the Mississippi station would not be materially diminished, while much would be accomplished toward the protection of the country from the introduction of yellow fever. It is to be hoped that the views recently expressed by the leading representatives of the commercial interests of New Orleans, and by the public press as an exponent of the prevailing sentiment of the community, will induce the State board of health of Louisiana to reconsider its action, and to co-operate with the National Board in the measures by which it is believed that the quarantine for the protection of the Mississippi Valley may be rendered efficient as a means of sanitation with a minimum interference with trade and travel. For further details relating to the operations of the Board at and in the vicinity of New Orleans, reference is respectfully made to Appendix R, containing extracts from the report of Dr. S. M. Bemiss, a member of this Board, who had charge of its interests on the Gulf coast.

INTER-STATE QUARANTINE.

Referring to the first annual report of this Board, dated January . 1880, for a statement of the considerations which determined the Boar to establish inter-State quarantine for the benefit of the Mississippi Valle States, at their request, by organizing a system of sanitary inspection of steamboats and other river craft, to be conducted at various point on the Mississippi River, namely, at New Orleans, at Bayou Sara, an in the vicinity of Vicksburg, Memphis, and Cairo, the Board confidentl affirms that the advantages which have been realized by their instru mentality in preventing the spread of disease, in restoring confidenc all along the river, and in thus preventing the imposition by State anc local authorities of needless and burdensome restrictions on commerce have been so vast as to warrant the assertion that they would have been cheaply purchased at the cost of all the money placed at the control of the Board, though nothing else had been gained. This position is held to be fully justified by the facts and testimony cited in the report of Dr. R. W. Mitchell, a member of this Board assigned to special duty as director of the service, under whose judicious and energetic administration such favorable results were realized. Attention is specially invited to the testimony of the Memphis Cotton Exchange, and kindred bodies in Little Rock, Ark., Shreveport, La., Vicksburg, Miss., and elsewhere; by the general superintendent of the Mississippi and Tennessee Railroad, and the officers of other leading railroad lines; by the superintendent of the Saint Louis and Vicksburg Anchor Line of Packets, and the representatives of various other similar lines of railroad and packet companies, as cited in Dr. Mitchell's report, a copy of which, marked S, is appended hereto. The largest item of expense incurred in connection with this service was the cost of the sanitary patrol boat, the H. H. Benner, used to enable the director of the service to visit inspecting stations, to board steamers in transit, and in case of epidemics to convey assistance to isolated communities. Had the Board possessed such a patrol boat in the summer of 1879, there can scarcely be a doubt but that it would have been possible to stamp out the disease in several places before it had caused a tithe of the mortality and interruption to business which ensued in those localities.

In this connection it is pertinent to refer to the significant testimony of Dr. J. H. Rauch, secretary of the State board of health of Illinois, which, having been addressed directly to this office, was not cited in Dr. Mitchell's report.

EFFECTS OF QUARANTINE ON INTER-STATE TRAFFIC.

Inclosed herewith please find an official report of the tonnage of the Illinois Central Railroad at Cairo for the last six months of the years 1878 and 1879.

Tonnage forwarded from and received at Cairo.

Months.	Forwarded.	Forwarded.	Received.	Received.
	1878.	1879.	1878.	1879.
July	10, 071, 800	20, 914, 900	28, 550, 200	48, 574, 600
August	10, 510, 400	19, 050, 200	31, 124, 000	52, 575, 200
September	10, 282, 200	17, 218, 200	23, 864, 100	60, 671, 600
October	10, 491, 600	22, 523, 600	48, 459, 500	71, 044, 000
November	10, 004, 500	27, 050, 100	61, 854, 600	60, 066, 700
December	26, 940, 100	23, 076, 800	70, 558, 800	74, 187, 700
Total	87, 300, 600	129, 833, 800	267, 411, 200	367, 069, 800

In this statement will be found an illustration of the effect upon commerce by the different systems in vogue in the management of yellow fever in the respective years. While it is true that the general increase of trade had its influence, it is fair to assume that this is not sufficient to account for the difference that obtains in the statement. In 1878, there was practically a quarantine excluding everything that came from the South, while in 1879 it was one of inspection, excluding only dangerous articles. This result could not have been brought about without the co-operation of the National Board of Health, as our Board without this co-operation could not have permitted the immense amount of material to be brought into the State from the South during the months of July, August, September, and October. It required my constant presence at Cairo (especially in July) and my repeated assurances to the local authorities that every precaution was being exercised at New Orleans and along the entire route to prevent the introduction and spread of the fever northward to allay their fears, as this year a large number of the citizens of Cairo were favorable to a quarantine of exclusion. Such was the feeling of apprehension that fully one-third of the population of Cairo, from July 15 to September 1, were ready to leave the moment the first case appeared, no matter whether it was of foreign or local origin.

The Illinois Central Railroad pays to the State of Illinois 7 per cent. of its net earnings, and it is not presumption to say that the increase of revenue, as the result of the course pursued during the months of July, August, September, and October, 1879, amounted to more than three times times the amount appropriated by the State for sanitary purposes. It must also be borne in mind that this does not include a statement of the difference in the receipts from passengers, or the trade of the Cairo and Vincennes and Cairo and Saint Louis Railroads, and of the river traffic.

To the same cause can be attributed the fact that we did not have a single case of yellow fever in our State in 1879.

In view of such beneficent results in the protection of the public health and the removal of disastrous obstructions to inter-State commerce, the Board is strongly impressed with the force of the considerations presented by Dr. Mitchell in favor of the policy of extending the service in question so as to include that portion of the Mississippi which is between its mouth and the city of New Orleans. If their expectations with regard to the probable prospective co-operation of the State board of health of Louisiana in connection with this service should be fully realized, the estimated cost of the additional equipments for the service will be insignificant in comparison with the positive and material benefits to be gained.

FINANCES OF THE BOARD.

In deference to the will of Congress, as indicated in the debate on the sundry civil appropriations in the last days of the last session, the Board suspended its proposed operations on Blackbeard Island, in Sapelo Sound, and at Hampton Roads, and in consequence thereof the disbursements for the last six months have been short of the estimates submitted to Congress last year. But it is respectfully submitted that there is a very urgent need of substituting for the imperfect quarantine arrangements at Norfolk and on the Georgia coast a more effective instrumentality for preventing the introduction of infectious diseases from foreign countries, and an equally urgent necessity for establishing a similar quarantine station on the coast of Texas. Moreover, the Mis-

sissippi River inspection service will be greatly improved at a sma additional annual cost by the adoption of the measures recommende by Dr. Mitchell in his report.

To meet these and other desirable ends, the Board submits its esti mates for the fiscal year ending June 30, 1882, and earnestly solicits the ap proval by Congress of a policy which, according to the testimony of board of trade and chambers of commerce, and other parties interested in inter State commerce, has promoted that commerce in so considerable a degree while at the same time giving more or less effective protection to the public health, so far as the same may be endangered by the transit of infected persons or things on the public highways, and their introduction into places previously exempt from infectious diseases.

In this connection the Board takes occasion to say that although by the concurrent opinion of the most eminent yellow-fever experts there were several cases of that disease in the vicinity of New Orleans, and although a number of undoubted cases have recently occurred at Key West, the Board did not deem it expedient to use any part of the contingent appropriation of $100,000 provided for such cases. This decision seemed to be justified by the fact that in neither case was there manifested any disposition to the spreading of the disease beyond the localities in which it first appeared.

The case of Key West is a peculiar and exceptional one, and for reasons set forth in the report of Dr. Cochran, a sanitary inspector of this Board, a copy of which will be found in the appendix of the last annual report, the Board did not consider it necessary or expedient to report the facts to the President of the United States with a view to the establishment of a compulsory quarantine in conformity with the provisions of section 3, act approved June 2, 1879, to prevent the introduction of contagious and infectious diseases into the United States. The cost of such an establishment would probably be disproportionate to the resulting benefits in view of the comparatively slight danger of the transmission of the infection from that city, except by sea-going vessels, which, if bound to other United States ports, can be quarantined at the ports of final destination. In view, however, of the frequently recurring introduction of yellow fever into Key West and the refusal of its authorities to apply measures of quarantine, this Board has considered it to be its duty to advise the health authorities of all ports having communication with Key West during warm weather to take special precautions in dealing with vessels from that port.

In accordance with the views hereinbefore stated, the following estimates of expenditures for the fiscal year ending June 30, 1882, are respectfully submitted, along with a statement of expenditures from the organization of the Board to December 31, 1880, with a statement in detail of the expenditures for the last two quarters.

It is also requested that the contingent appropriation of $100,000, which was to be available in the event of an outbreak of epidemic disease, be renewed under the same conditions for the next fiscal year.

Statement of the expenditures of the National Board of Health for the six months ending December 31, 1880.

On what account.	Total for quarter ending September 30, 1880.	Total for quarter ending December 31, 1880.	Total for the 6 months ending December 31, 1880.
Floating quarantine on Mississippi River	$9,988 39	$8,830 21	$18,827 60
Ship Island quarantine	11,737 28	10,777 10	22,514 38
Blackbeard Island quarantine	2,767 42	1,782 11	4,549 53
Elizabeth River quarantine	2,317 75	240 00	2,557 75
Aid to Pensacola, Fla	3,195 63	1,066 59	4,262 22
Aid to Pascagoula, Miss	97 58	71 70	169 28
Aid to Hancock County, Mississippi	319 35	300 00	619 35
Aid to Harrison County, Mississippi	353 70	413 20	766 90
Aid to State board of health, Louisiana	1,490 00	411 90	1,901 90
Aid to State board of health, Texas	125 00	150 00	275 00
Aid to Charleston, S. C	40 20	1,114 25	1,154 45
Havana commission	662 30	....	662 30
Pay and expenses inspectors at Havana, Memphis, &c	5,069 15	2,051 00	7,120 15
Special scientific investigations	849 73	1,900 33	2,750 06
Pay and expenses members of the Board	2,559 20	1,938 08	4,497 28
Storage of tents, &c	260 75	....	260 75
Printing of the Bulletin of National Board of Health	2,147 89	2,131 05	4,278 94
Printing of blanks, &c	172 65	58 07	230 72
Pay of clerks, messengers, &c	4,450 39	4,488 99	8,939 38
Rent, light, and fuel	212 40	330 80	543 20
Telegrams	96 11	89 52	185 63
Furniture, stationery, &c	765 80	280 98	1,046 78
Miscellaneous expenses National Board of Health	242 86	270 03	512 89
Total for the quarters ending September 30, 1880, and December 31, 1880	49,921 53	38,204 91	88,126 44
* From the date of organization of the Board to June 30, 1879, there was expended			9,146 41
* From June 30, 1879, to June 30, 1880, there was expended			266,762 16
Total amount expended by the Board from date of organization			364,035 01

* Detail statement of these expenditures heretofore reported to Congress.

Estimates of expenditures for the fiscal year ending June 30, 1882.

For maintenance of quarantine station at Ship Island, Miss., including pay of inspector in charge of station, officers and crews of vessels, employés at station, fuel and lights for station and vessels, provisions, medicines, disinfectants, and incidentals	$19,131 50
For repairs of vessels and stations	3,000 00
For maintenance of Mississippi River inspection service, including pay of employés, cost of fuel, provisions, medicines, disinfectants, and incidentals at four stations, viz, Vicksburg, Red River, Memphis, and Cairo	33,793 71
For additional steam-tug, launch, and flats	18,000 00
For repairs	4,000 00
For construction of a temporary quarantine station at Sapelo Sound, Georgia	30,000 00
For maintenance of quarantine station at Sapelo Sound, Georgia, including pay of inspector in charge, employés at station, officers and crew on quarantine vessels, fuel, provisions, medicines, disinfectants, and incidentals	11,119 01
Repairs to quarantine wharf at Charleston, S. C	12,000 00
For construction of temporary quarantine station at Hampton Roads, Virginia	30,000 00
For maintenance of same	5,000 00
For repairs	3,000 00
For construction and maintenance of a temporary quarantine station near Galveston, Tex	50,000 00
For aid to State and local boards of health	25,000 00
For miscellaneous investigations into matters affecting the public health.	30,000 00
For per diem and expenses of members of the National Board of Health..	18,000 00
For per diem and expenses of inspectors of the National Board of Health..	10,000 00
For contingent expenses	40,000 00

Office expenses:

For furniture		$500
For clerks, messengers, and laborers		22,940
For rent, light, and fuel		1,760
For printing Bulletin, blanks, &c		10,000
For stationery		1,000
For telegrams		2,000
For postage		1,000
For miscellaneous expenses		5,000
		389,184
Total appropriations	$625,000 00	
Total expenditures to January 1, 1881	364,035 01	
Balance January 1, 1881	260,964 99	
Estimated expenditures January 1, 1881, to June 30, 1881	75,000 00	
		185,964 9
Additional appropriations required by above estimates		203,219 9
For quarantine purposes and for aid to State and local boards of health, to be used only in case of an epidemic		100,000 0

Respectfully submitted on behalf of the National Board of Health.

J. L. CABELL,
President National Board of Health.

T. J. TURNER,
Secretary National Board of Health.

APPENDICES.

REPORTS AND PAPERS.

APPENDIX A.

EXTRACT FROM REPORT FOR QUARTER ENDING MARCH 31, '80.

QUARANTINE.

In compliance with the positive requirements of the law as set forth in section 3 of the act approved June 2, 1879, and in conformity with the announcement contained in the Annual Report of the Board initial steps have been taken, with the approval of his Excellency the President of the United States, for establishing quarantine stations and erecting quarantine buildings at Ship Island off the coast of Mississippi, at Blackbeard Island in Sapelo Sound off the coast of Georgia, and at Hampton Roads, Virginia.

At the first named station the necessary quarantine buildings will be erected with the permission of the Secretary of War, on grounds belonging to the United States and in possession of the War Department.

It is proposed to build a hospital and other necessary structures for the Hampton Roads station, on sheathed piles in shoal water on the edge of the channel. A bill ceding jurisdiction and granting title to the United States passed both houses of the Virginia legislature at its recent session without opposition and then only required the signature of the governor.

It is ascertained by a letter from his excellency that he would have given his approval if the bill had reached him in time, but that and other bills came into his hands only a few minutes before the adjournment of the legislature, and it is believed that an approval given after such adjournment would have been invalid.

The Board have assurances from the attorney-general that there will be no difficulty in perfecting the title at the next meeting of the legislature. In the meantime it is proposed to make use of the hulk "Savannah" now lying at the navy-yard in Portsmouth, Va., which has been turned over to the Board by the Secretary of the Navy, as a temporary hospital ship.

It is proposed that the buildings to be immediately erected at the Ship Island and the Sapelo Sound stations, and eventually at Hampton Roads also, be made by contract after duly advertising for the same in conformity with law, and it has been ordered that the specifications be prepared by the several members of the Board in charge of the respective stations, after consultation with the engineer officers who have been detailed by the Secretary of War for the purpose, namely Capt. W. H. Heuer for the Ship Island station, Capt. Jos. C. Post for the Sapelo Sound station, and Capt. C. B. Phillips for the station in Hampton Roads.

In the opinion of the executive committee of the Board it is extremely desirable to establish a quarantine station in Galveston Bay, for the protection of the Texan coast, but at the date of the last meeting of the Board it was believed that adequate provision had been made or would be made by the State or local authorities. At that date the municipal authorities of Galveston had declined to adopt the rules and regula-

tions recommended by this Board, and had made no application for aid which could only have been granted on the condition of the adoption and enforcement of these rules. Accordingly the Board gave no authority to the executive committee to establish a quarantine station on the Texan coast.

Recently, however, an application from the authorities of Galveston, forwarded by the Hon. J. H. Reagan, has been made to the executive committee, requesting the establishment of a quarantine station at that or some neighboring locality on the Texan coast.

Beyond obtaining the approval of the President of the United States the executive committee has not felt itself authorized to take any action in the case, but proposed to refer the matter to the full Board at its semi-annual meeting early in May.

The committee is, however, satisfied that the rules and regulations to be prepared by the Board and approved by the President of the United States as necessary for the protection of the public health with as little restraint upon commerce as may be consistent with such protection, cannot be enforced without the aid of the National Board of Health.

Attention is called to the following report of Dr. John H. Pope, a sanitary inspector in the service of this Board, and to resolutions adopted by the Galveston board of health bearing upon the subject:

REPORT OF DR. JOHN H. POPE.

GALVESTON, TEXAS, *March* 19, 1880.

DEAR SIR: I was not in possession of sufficient information on the subject of your communication of the 9th instant, to answer your inquiries intelligently. Hence I visited Galveston to get a better knowledge of the subject. I called at Houston to see Dr. Rutherford, having previously telegraphed him, but I found on my arrival, he had left for Brazos de Santiago, before receipt of my telegram. I continued my journey to Galveston, hoping Dr. Rutherford might return by the time I finished my investigations at this place.

The present quarantine establishment is not sufficient for this port.

The station used during 1870 is located at the east end of Galveston Island, about 2½ miles from Galveston wharf (marked on the accompanying chart, in red ink, "quarantine 1879"). The point farther east marked "quarantine" in black ink is the old station used prior to the storm of 1875, which destroyed it. At the location used in 1879, there are two houses about 12 and 18 feet square, respectively. The one used as quarters for the boatmen belonging to the station is set on posts about 10 or 12 feet above ground, and is in a dilapidated condition. The other used by the quarantine officers as residence, has two rooms and a kitchen, and is raised about 12 feet above ground on piling driven 8 feet into the sand. There is a wharf 160 feet long to the landing for the quarantine officers' yawl. Two yawls 18 feet long, 8 inches draft, and one skiff belong to the station. There is also one wall tent. There is no furniture at the station except one table and two or three chairs, one signal light and "several lights and lanterns used about the houses." This information I obtained from Dr. M. R. Brown, quarantine officer in charge during 1879.

The regular session of the sixteenth legislature, 1879, appropriated for quarantine purposes as follows:

For pay of State health officer, and for expenses incurred under quarantine laws in the State $20,000 a year for two years.

"For building quarantine station houses at such points as the health officer may deem advisable $5,000." (Vide Ch. 148, p. 157—General laws of Texas, 1879, Reg. Sess.)

At the special session sixteenth legislature, 1879, $7,000 additional was appropriated "for quarantine buildings, wharves, &c., for quarantine purposes; *provided* it be used at the following points and places; Brazos de Santiago, Corpus Christi, Indianola, Galveston, Sabine Pass, Orange, Denison, Texarkana, and Marshall." (Vide Gen'l Laws, ch. 37, p. 34, special session sixteenth legislature, 1879.)

It will thus be seen that $12,000 was the total appropriated for buildings, wharves, &c., for all the stations (nine in number) on the Gulf Coast and inland border.

Out of this appropriation the State health officer has had erected, on Pelican Island, two buildings the plan of which I send you. One of these buildings is a hospital, the other for quarantine officer and assistants. They are located about the tripod marked red ink on Pelican Islands (see tracing).

There are no warehouse facilities, no barges or lighters for transferring cargo.

I think one complete quarantine station on the Texas coast would, for the present, relieve the commerce of Texas from the embargo placed on it by non-intercourse quarantine. In consultation with the health authorities here, they express themselves in favor of allowing commerce to go on, if the vessels, cargo, crew, and passengers can be subjected to proper treatment at a complete quarantine establishment. From my experience at the ports west of this, during the last summer, I am of opinion that the principal thing in the way of a national quarantine on this coast is want of facilities for handling cargoes, &c., that may be from infected ports. You ask whether such station "should be established at Galveston or farther west on the coast." I think some point near the entrance to Galveston Bay would be most suitable, and for the following reasons:

1. It is most convenient for the commerce of Texas. The commerce of Sabine Pass is principally a coasting lumber trade with ports west of it. The entrance to the ship channel leading to Clinton and thence by rail to Houston is through Galveston Bay. The geographical position of Galveston makes it more nearly on the route of vessels plying between Indianola, or Corpus Christi, or Brazos de Santiago, and ports most liable to become infected with yellow fever, except the trade between Mexican ports and Texas ports west of Galveston. But this Mexican trade with ports west of Galveston is very light. Nearly all the commerce between Mexican and Texan ports enters at Galveston.

There is a line of English steamships that ply between Liverpool, Hamburg, and Bordeaux, and Brazos de Santiago, via Vera Cruz and other Mexican ports. Their principal cargo is bonded goods for Matamoras and interior of Mexico. They do not bring much from Mexican ports for Brazos de Santiago—occasionally some passengers. The chief source of danger is from taking on goods for Europe at an infected Mexican port, and mixing with cargo destined for Brazos de Santiago, thus infecting the whole cargo. It occurs to me that the simplest remedy for this would be for these ships to come first to Brazos de Santiago and go thence to the Mexican ports. In my inquiries last summer I could ascertain no reason why this could not be done, except that by the route the vessels take now they obtain some advantage of winds and currents.

The Indianola cattle trade with Havana is a very important one, but Galveston does not lie far out of the route taken by the ships. A large majority of the vessels enter at Galveston that come to Texas from ports most liable to have yellow fever, and in fact any disease for which quarantine is established. The ports I refer to are the Mexican, South American, West Indian, and South Atlantic and Gulf ports of the United States.

So much for the commerce as it is now. If in the future the ports west of this should have their railways so extended to the interior as to largely increase their importance as ports of entry, and an additional quarantine station should be needed, the curved line of the Texas coast would seem to make it desirable to have the stations as near as possible the extremities of the arc; so that one or the other of such stations would lie near the route of vessels coming from any direction. In such event, Galveston would be a better point for the present station than a point farther west.

2. I am assured the land for site can be procured without cost in Galveston Bay. I have addressed the following communication to the mayor and council of Galveston in reference to this point:

"GALVESTON, TEX., *March* 19, 1880.

"*To the Hon. Mayor and Common Council, City of Galveston*:

"GENTLEMEN: I have the honor to request information on the following points, to be transmitted to the office of the National Board of Health, Washington. Has the City of Galveston, through its mayor and common council, such jurisdiction over Pelican Island as to grant the use of said island to the National Board of Health for the purpose of erecting and maintaining a quarantine establishment for the benefit of the commerce of Galveston and other accessible ports—such a quarantine establishment, for instance, as is proposed to be erected at Ship Island? If the city has such jurisdiction, will it grant the use of said island to the National Board of Health for the purposes indicated, in consideration of the National Board of Health erecting and maintaining such quarantine establishment?

"A reply, at your earliest convenience, will very much oblige your obedient servant.

"JNO. H. POPE,

"*Sanitary Inspector, National Board of Health.*"

The mayor assured me he would get the council together as soon as possible and act on the communication. In conversation with the mayor and two of the aldermen, I was told they had no doubt the island could and would be granted as requested. The city council cannot sell the island, nor can it be sold under execution or otherwise to pay any debt of the city. The meeting of the council will probably be held next Wednesday, 24th instant. I will forward the answer.

The land about entrance to Matagorda Bay is either the property of private individuals, and would have to be purchased or condemned and appraised by a commission,

or it is the property of the State, and would require an act of the legislature to pas title. Besides, isolation could not be made so satisfactory on either Matagorda peninsula, or on the islands on the other side of the channel.

Pelican Island is the most suitable point in Galveston Bay for the location of a quarantine station. The only other place I thought worth considering was Bolivar Peninsula. This is leased and occupied by the government force in charge of the harbor improvements.

Pelican Island is north of Galveston about three miles, and is a little less distant from the mainland. It lies between the channel leading up to Clinton and the one leading to Galveston Wharf. The island is about one and a half miles long and about three-fourths of a mile broad at its widest point. It is composed of shell and sand, has an elevation or ridge running almost the entire length of the island, near its northern shore. The top of this ridge is from 3 to 4½ feet above ordinary high-tide. The ridge is from 100 to 200 feet wide. South of this ridge the island is low and flat, subject to overflow in high-tide. In addition to the grassy vegetation growing on most of the island, the ridge is covered with a chaparral or thicket of scrubby growth, some of which is mesquite.

It is said the island was submerged, during the cyclone of 1875, only to depth of 10 inches. Vessels only drawing 10 inches went aground on this island during the severest part of that storm.

The buildings of the proposed quarantine station should be located along the ridge. The warehouse and wharf would be somewhere near the tripod (marked in red ink on the tracing). If possible it should be farther east, but this will have to depend on the nearness of the channel. The wharf should be extended out to ten feet water.

The quarters for passengers not sick should be toward the west end of the island, where they could be isolated and have that portion of the island for out-door exercise and recreation. The hospital for sick with other than infectious diseases should be next in order as we go from west to east; then quarters for officers and men in charge of station; then warehouse and wharf, and finally hospital for infectious diseases, except small-pox, for which a hospiial could be located on the south side of the island where the fisherman's hut is.

It will require a wharf about 1,900 feet long, according to latest charts, to reach a channel of water 10 feet deep. I would advise that soundings be made before the location is determined on.

All the buildings should be on piling, extending about 8 feet into the ground and 4 or 5 feet above ground. This opinion is founded on the judgment of those better acquainted than I am with the effects of the gales and cyclones on this coast. There should at least be a sufficient number of the houses raised thus on stout piles to insure refuge in event of storm.

As to the capacity of the warehouse, it should be large enough to accommodate the cargo of a 2,500-ton vessel. There is only one vessel entering here larger than this, to wit, the Colorado, 2,750 tons. The heaviest draught vessels are those running between this and New York City. The average tonnage of the steamships entering here is about 1,200 or 1,300 tons. Vessels engaged in the South American and Mexican trade are smaller. If success follows the efforts to deepen the bar, larger vessels will doubtless come to this port, but this will at least be several years.

The buildings erected by the State, I have no doubt, would be allowed to the National Board of Health for their use in the event the proposed station were established here. These could be utilized as quarters for officers and men or some other purpose. These buildings require some repairs on account of the mischief inflicted by pic-nic or fishing parties. They also require some additional work to make them ready for use. Some of the walls are badly warped on account of green lumber. There is no kitchen nor cooking-house. The water-closet of the hospital needs boxes or drawers if the dry earth system is to be used. As it is arranged now the droppings of excrement and urine fall on the surface of the ground under the hospital. Cypress piling will cost 15 cents a running foot (will last three to five years, uncoppered, when used for wharves), and lumber $16 a thousand feet, delivered on the island.

The boarding station should be fixed by buoys at a point east of where the two channels diverge to each side of Pelican Island. Some vessels have to be boarded and inspected outside the bar on account of their heavy draught. For this purpose and for lightering there should be at least one steam tug and two covered barges.

It is a part of the general plan, as discussed with the health authorities here, that the local board of health shall have its inspector or quarantine officer at the old quarantine station at east end of Galveston Island. All vessels coming over the bar and passing to the left of Pelican Island in the channel toward Galveston wharf will be boarded by the Galveston quarantine officer. If the ship is suspected she is sent to the National Board of Health station on Pelican Island. The Galveston quarantine officer also boards all vessels for Galveston that have passed through the quarantine process at the National Board of Health station, to see if they have the certificate of the National Board of Health quarantine officer, and are in apparently good sanitary condition.

The following communication was addressed to the board of health, and the inclosed resolutions passed in answer thereto:

"*To the Galveston Board of Health:*

"GENTLEMEN: I desire information on the following points, for the use of the National Board of Health, as important in determining the establishment of a complete quarantine station on the Texas coast under the direction of the National Board of Health, such station, for example, as is proposed to be established at Ship Island:

"1. If the National Board of Health should erect and maintain such quarantine establishment, will the health authorities of Galveston require all infected and suspected vessel, before landing or discharging at the port of Galveston, to be properly treated at said station for the elimination of infection and contagion?

"2. Will the health authorities of Galveston allow free *pratique* to vessels having certificate of good sanitary condition and freedom from infection from the quarantine officer in charge of the National Board of Health station, provided your quarantine officer or inspector should find the vessel free from disease and apparently in good sanitary condition?

"I have the honor to be, yours, respectfully,

"JNO. H. POPE,
"*Sanitary Inspector, National Board of Health.*"

As will be seen by the resolutions, both questions were answered in the affirmative.

Before the old station at east end of Galveston Island could be used for boarding and inspecting station a good deal of repairing would have to be done. The probable cost would be about $500. I have understood there are some funds in the State treasury that can be used for such purpose, but I do not know, until I see Dr. Rutherford.

There is ample room for *anchorage* to the north of Pelican Island.

I am of opinion that all the stations or ports on Texas coast would adopt resolutions similar to those passed by the Galveston board, in reference to making suspected vessels come to the National Board of Health station, and admitting them on certificate of the National Board of Health quarantine officer, provided no sickness should be on board and the vessel in apparently good sanitary condition. I judge this by the temper of the health authorities in my inspection district last summer. I have been shown a letter from Governor Roberts to Dr. Haden, president of Galveston board of health, in which he speaks of calling a meeting of the various local health authorities in Texas for the purpose of having uniform regulations during the coming season. It will be well to bring before that meeting this matter of co-operation through means of a National Board of Health station. I suggested it to Dr. Haden. I have very little doubt all the Texas ports will be glad of an opportunity of keeping up their commerce by means of a complete quarantine station under the direction of the National Board of Health.

Dr. Rutherford is expected back on to-morrow or next day. I will keep this report open and wait until Monday for him. If the rough weather now prevailing detains him longer than Monday morning I shall leave for Marshall and trust to an understanding by letter. In a recent letter Dr. Rutherford informed me he intended resigning his position as State health officer on his return from the tour of the stations. I have no intimation as to who will be his successor.

MARSHALL, TEX., 23.

Dr. Rutherford arrived at Galveston Monday morning, and I had an opportunity of consulting him.

We agree that there should be a complete quarantine station for Texas ports; that Pelican Island in Galveston Bay is, all things considered, the best location for such station; that if the National Board of Health will erect and maintain such station, we are of opinion all Texas Gulf ports will require infected vessels to be treated there before admitting them, and that the health authorities at the various ports will admit vessels that hold certificate of the officer in charge of the National Board of Health station, provided there is no sickness on board and the vessel is in apparently good sanitary condition.

I asked the State health officer if an arrangement could be made by which the State would allow the National Board of Health the use of the buildings already on the island as a part of the complete quarantine establishment proposed. He said the National Board should pay the State the actual cost of the building, which is about $3,000. I suggested that the proposed scheme was in the interest of Texas commerce and that the State could well afford to allow free use of the buildings if the National Board would add sufficiently to them to make the station of real service in preventing disease and allowing commerce to go on. He answered that if the National Board should maintain and operate the station they had best own all the buildings. I replied that it might be a condition of the appropriation by Congress that the States benefitted should gradually pay pack to the general government the money allowed for these stations; but that whether that should be a proviso or not, the National Board was trying to devise means of relieving commerce of southern ports from some of the

burdensome restrictions, and the States ought to obtain the benefit of it if possible. He said he was heartily in favor of co-operation looking to that end. He finally remarked that the appropriation for Galveston was exhausted and that he would have no place to put the Galveston quarantine officer; that if the National Board got control of the buildings on Pelican Island they (the National Board of Health) should at least put the old station at east end of Galveston Island in condition to render it safe. I asked if there was not $600 in State treasury that could be made use of for purpose of repairing these buildings. He informed me that money alluded to belonged of right to the station at Orange, on the Texas and New Orleans Railroad; that he had intended building a warehouse for disinfecting the infected goods that might come by railroad. The railroad company were talking of putting up a builing for the purpose and, if they did so, Dr. R. thought may be this money ($600) might be diverted to another station. This makes the using of it at Galveston depend on a contingency. Dr. Rutherford said he would write to the National Board of Health on this subject. He told me I was at liberty to inform you he would resign his position as State health officer at an early day, and he feels assured that Dr. R. M. Swearingen, of Austin, will be his successor.

If the National Board of Health should decide to recommend an appropriation for the station on the Texas coast, it is probable the station could not be completed for use this season. If, however, the warehouses—say two of them, each 140 by 24 by 12 feet—could be erected in time for handling cargoes, and the station furnished with steam-tug and two lighters, this itself would go far toward relieving the embargo at Texas ports. Until other buildings were complete, tents could be used if necessity required. It would be well to have tents on hand as part of the permanent equipment of the station.

I have the honor to be, very respectfully, yours,

JNO. H. POPE.

Dr. T. J. TURNER,
Secretary National Board of Health, Washington, D. C.

[Extract from minutes of Galveston board of health agreeing to co-operate with the National Board of Health.]

OFFICE OF THE BOARD OF HEALTH,
Galveston, Tex., March 20, 1880.

SIR: A called meeting of the Galveston board of health was held this day at 10 o'clock a. m.

Present: Dr. John M. Hayden, president, Dr. T. McClanahan, Dr. E. H. Watts, Messrs. N. N. John, S. B. Noble, J. Fooke.

The president stated that the meeting was called to receive and act upon a communication from Dr. John H. Pope, sanitary inspector of National Board of Health, relating to quarantine facilities on the coast of Texas.

The communication from Dr. Pope was read to the meeting in session and the following preamble and resolutions in reply offered by Mr. Noble:

"Whereas, Dr. John Pope, sanitary inspector of the National Board of Health, in order that he may be able to report definitely to said National Board as to the advisability of establishing and locating on the Texas Coast a complete quarantine station, has propounded certain questions looking to the desirability of establishing and locating said quarantine station at Galveston; therefore—

"*Resolved*, That if the National Board of Health should erect and maintain such quarantine establishment as referred to us in Dr. Pope's communication of the 19th instant, the health authorities of Galveston will require all infected vessels, before landing or discharging at the port of Galveston, to be properly treated at said station for the elimination of infection and contagion.

"*Resolved*, That upon the erection of said proposed quarantine establishment the health authorities of Galveston will allow free *pratique* to vessels having certificates of good sanitary condition and freedom from infection, from quarantine officer in charge of the National Board of Health station: *Provided*, Our quarantine officer or inspector should find the vessel free from disease and apparently in good sanitary condition."

The motion to adopt, as put by Mr. Noble, was seconded by Mr. John, and unanimously carried.

I certify that the foregoing is a correct copy from proceedings Galveston board of health, March 20, 1880.

CLARK CAMPBELL, M. D.,
Secretary Board of Health.

Attest:
P. S. WREN,
City Clerk.

[SEAL.]

APPENDIX A2.

REPORT FOR THE QUARTER ENDING JUNE 30, 1880.

NATIONAL BOARD OF HEALTH,
Washington, D. C., July 15, 1880.

Hon. JOHN SHERMAN,
Secretary of the Treasury, Washington, D. C.:

SIR: The National Board of Health, by its executive committee, respectfully submits, as required by law, the following statement of the operations and expenditures of the Board for the quarter ending June 30.

SPECIAL INVESTIGATIONS AND SANITARY SURVEYS.

Since the date of the last quarterly report the following-named investigations then in progress have been completed, viz:

1. An investigation as to the best method of determining the amount and character of the organic matter in the air, by Prof. Ira Remsen, of the Johns Hopkins University of Baltimore.
2. A report on water analysis in general, by Dr. Charles Smart, assistant surgeon, U. S. A.
3. An investigation by experimental and clinical methods into the causes and nature of diphtheria, by Dr. H. C. Wood, of Philadelphia.
4. A sanitary survey of the eastern coast of New Jersey bordering on New York Harbor.
5. A partial survey of a portion of Baltimore City.

With the exception of the last-named survey, the reports of these several investigations are in the possession of the Board in the original manuscripts. It is proposed to publish some or all of them in the Bulletin, and when this is done copies of the same will be transmitted to your department.

6. A report by Dr. J. J. Woodward, U. S. A., on the pathological histology of yellow fever.

But one additional investigation has been ordered since the date of the last quarterly report, namely, an investigation into the adulteration of food, by Dr. Charles Smart, U. S. A.

CONFERENCE ON VITAL STATISTICS.

In accordance with a design explained in the last quarterly report, this Board invited all persons interested in vital statistics, and especially those who were charged with the duties of State or municipal registration, to meet with it in Washington on the 6th of May for the purpose of considering the best methods for the collection and publication of such statistics. In response to this invitation a number of gentlemen from different sections of the United States between Boston and New Orleans met with the Board in open conference, which occupied the days of May 6 and 7. The proceedings, with the exception of an in-

teresting paper by Professor Abbé on the relations of meteorologic phenomena to vital statistics, which was temporarily mislaid, have bee published in Supplement No. 5 of the National Board of Health Bulleti

QUARANTINE.

Referring to the last quarterly report for an exposition of the view and purposes then entertained by this Board as to the importance an necessity of establishing and maintaining quarantine stations under th auspices and control of the Board at Hampton Roads, Sapelo Sound, an Ship Island, it is a subject of regret that, owing to recent legislation by Congress, it has not been possible to carry out those views except in a very partial manner.

The funds at the disposal of the Board have necessitated, in the case of Hampton Roads, a temporary abandonment of a national quarantine, substituting therefor aid to the local authorities by the loan of a barge, purchased and equipped as a floating hospital at a cost not exceeding $600. This was found to be less expensive, and in all respects much better, than to repair and fit the hulk Savannah, lying at the navy-yard at Portsmouth, which, at the request of the Board, had been courteously granted for its use by the Hon. Secretary of the Navy. For a like reason a temporary arrangement has been made at the Sapelo Sound station by the use of hospital tents on the southern end of Blackbeard Island, and by the purchase of a steam-launch for boarding vessels. The erection of a hospital, warehouse, and wharf at Ship Island had already proceeded so far before any question arose as to make it inexpedient to alter the original plans of the Board in respect of that important station. In like manner the purchase of three steam-launches for the Mississippi River stations at Cairo, Memphis, and Vicksburg, and of a sanitary patrol steamboat to carry medical supplies and disinfectants at short notice to points on the river not directly accessible by means of railroads, had been contracted for at an early period of the spring.

This provision for aiding State and municipal boards of health in preventing the dissemination of the seeds of contagious and infectious diseases in conformity with the requirement of section 3, act approved June 2, 1879, is considered by this Board to be an indispensable means of effecting that end. It has accordingly prepared for this river inspection service two somewhat elaborate codes of rules and regulations, one set to be enforced in the absence of yellow fever or cholera in the Mississippi Valley, the other to be enforced when yellow fever exists at or in the vicinity of any port or place on the Mississippi River. These codes have been published in No. 50 of the Bulletin, and are hereto appended.

ANNUAL MEETING OF THE BOARD.

Within the period covered by this report the annual meeting of the Board was held May 4–10, inclusive, when its former officers were re-elected, and, in addition to other work, the by-laws were revised, as will be seen by reference to No. 46 of the Bulletin, May 15, 1880, a copy of which is herewith submitted.

REVISION OF RULES AND REGULATIONS.

At the same meeting the Board revised the rules and regulations for securing the best sanitary condition of vessels, including their cargoes,

passengers, and crews coming to the United States from any foreign port where any contagious or infectious disease exists. The rules then slightly modified were submitted to the President of the United States, and were approved by His Excellency June 17, and have been published in the Bulletin of the Board, No. 51, a copy of which is hereto appended.

The same number of the Bulletin contains the revised circular No. 7, addressed to State and municipal boards of health, and setting forth the rules which govern the National Board in co-operating with and aiding State and local boards of health in carrying out the ends of the act approved June 2, 1879.

The Board submits herewith a statement of its expenditures for the quarter ending June 30, 1880.

Very respectfully, your obedient servant,

J. L. CABELL,
President National Board of Health.

Statement of expenditures National Board of Health for the three months ending June 30, 1880.

For what purpose.	Expenditures from April 1, 1879, to and including March 31, 1880.	Expenditures during quarter ending June 30, 1880.	Expenditures from April 1, 1879, to and including June 30, 1880.
Furniture	$2,019 58	$1,648 06	$3,667 64
Employés	15,649 88	2,994 53	18,644 41
Miscellaneous expenses	1,559 96	241 26	1,801 22
Rent, light, and fuel	1,428 55	643 53	2,072 08
Stationery	1,466 95	574 69	2,041 64
Pay and expenses of Board	7,371 91	980 23	8,352 14
Pay and expenses of executive committee	2,932 88	1,277 90	4,210 78
Telegrams	1,553 00	154 55	1,707 55
Postage	765 08	200 93	966 01
Printing Bulletin	3,828 20	1,584 56	5,412 76
Printing blanks, &c	1,955 64	184 32	2,130 96
Pay and expenses of inspectors for quarantine purposes	13,611 29	1,113 74	14,725 03
Miscellaneous investigations, act March 3, 1879	5,551 97	4,019 27	9,571 24
Conference with sanitarians	178 25		178 25
Havana commission	12,333 84		12,333 84
T. J. Taylor, act June 2, 1879	540 00		540 00
January survey, Memphis	5,925 35		5,925 35
Floating quarantine stations on Mississippi River	4,195 75	36,042 36	40,238 11
Report on yellow fever epidemic of 1878		1,800 00	1,800 00
Ship Island quarantine	1,806 35	17,182 54	18,988 89
Blackbeard Island quarantine		6,660 48	6,669 48
For aid to Charleston, S. C., quarantine		38 60	38 60
For aid to Elizabeth River quarantine commission		3,812, 16	3,812 16
Expended in States:			
Louisiana	14,854 06	1,717 39	16,571 45
Tennessee	50,296 25	1,815 17	52,111 42
Mississippi	16,125 84		16,125 84
Illinois	3,849 77		3,849 77
District of Columbia	7,710 00		7,710 00
Arkansas	7,589 51	130 50	7,720 01
Texas	535 00		535 00
Alabama	2,195 46		2,195 46
Florida	3,006 28		3,006 28
Georgia		246 20	246 20
Totals	190,836 60	85,071 97	275,908 57

[From Bulletin No. 50, June 12, 1880.]

NATIONAL BOARD OF HEALTH.

MISSISSIPPI RIVER INSPECTION SERVICE.

In accordance with the recommendations of the various State boards of health a of the sanitary council of the Mississippi Valley, the National Board of Health l established its river inspection service for the purpose of preventing the introducti and spread of epidemic, contagious, or infectious diseases along the Mississippi Riv and of avoiding unnecessary obstruction to travel and traffic during the prevalence such diseases.

The experience of 1879 showed that such inspections secured an improved sanita condition of steamboats, barges, and other vessels; created in threatened communiti such a degree of confidence as led to the abandonment of conflicting and onerous qua antine regulations; and prevented the spread of disease along the river, although yello fever existed at several places in the valley.

The service provides a continuous sanitary supervision of vessels in transit on th Mississippi River, between New Orleans and Cairo, during the summer months; suc supervision being exercised through a corps of inspectors acting under uniform rule and regulations. The equipment of the service embraces—

A. Three intermediate inspecting stations, located as follows:

No. 1.—Near Vicksburg, Miss.

No. 2.—Near Memphis, Tenn.

No. 3.—Near Cairo, Ill.

These stations are designated by yellow flags during the day, and by yellow lights at night, and are provided with—

B. Steam-launches and yawls for the use of the inspectors in boarding boats arriving in the vicinity of their stations; and with—

C. Suitable locations (1) for the cleansing, disinfection, and other necessary treatment of *foul* or *infected* boats; (2) for the hospital treatment of the sick from such boats; and (3) for the temporary accommodation of other persons from such boats. There is also—

D. A sanitary patrol-boat for the use of the chief inspector in supervising the conduct of the service generally, and for the prompt conveyance of relief to isolated communities during epidemics.

During the last inspection season it was found possible to conduct this service with little or no delay, expense, or annoyance to river travel and traffic. With added experience, and a better equipment, it is believed that these inspections will prove of still greater utility in protecting the public health and in promoting commercial intercourse.

CODE A.

General rules and regulations to be enforced in the absence of cholera or yellow fever in the Mississippi Valley.

1. From and after May 1 of each year, and until the close of the inspection season as announced by the National Board of Health, all steamboats carrying passengers or freight, and all tugs, tow-boats, and barges, departing from the port of New Orleans for Vicksburg or above, should obtain a certificate of inspection (Form 1). The inspector of the Mississippi River service stationed at New Orleans shall, upon request of the owner, agent, or captain of such boats, make the inspections and furnish the certificate referred to.

2. Such request should be sent to the inspector, in writing, at least twenty-four (24) hours before the date of departure of the vessel (Form 2).

3. At an hour as near as convenient to the time fixed for departure, the inspector shall make a thorough examination of the boat with reference to the following points:

(*a*) Presence or absence, among passengers, officers, and crew, of dangerous sickness.

(*b*) Character and general sanitary condition of cargo.

(*c*) Condition of boat as to cleanliness of hold and bilge, and presence of rotten wood in hull.

4. On the completion of his examination, the inspector will fill out his record (Form 3) in accordance with the facts, and will furnish the master of the boat with a corresponding certificate (Form 1).

5. If, upon examination, the boat be found to be *foul* or the cargo in an insanitary condition, the inspector will advise suitable treatment.

6. A vessel shall be considered "foul," within the purview of this code:

1. If the hold contains decomposing organic matter of any description, or is wet and unventilated.

2. If the bilge is dirty and gives off offensive odors.

3. If the water-closets and urinals are unclean.

4. If the boiler-deck, texas, or other accommodations for the crew are dirty and badly ventilated.

5. If there is much decaying or rotten wood untreated with zinc-iron, copperas solution, or lime-wash.

6. If the cargo comprises articles or material whose exposure and handling are prejudicial to health by reason of decay and decomposition of organic matter, animal or vegetable. Particular attention should be given to the history of rags, paper-stock, and second-hand textile fabrics—especially clothing and bedding—composing cargo; as also all articles from tropical ports, and to the condition of fruits, vegetables, or other articles liable to decomposition.

7. The necessary clea sing and disinfection of a foul boat should be done by the crew of the boat under the supervision of the inspector. Until this is completed and the sanitary condition of the boat is satisfactory he will either withhold the certificate, or, in his discretion, indorse the same in accordance with the facts.

8. Boats arriving from below at the ports of Vicksburg, Memphis, or Cairo, without having passed examination at the intermediate inspection station or stations, will not be allowed by the local authorities to land passengers or freight, nor to have any intercourse with said ports, until they shall have returned to the nearest station and there complied with the requirements of this code.

9. On nearing an inspection station the boat should give her usual signal (by whistle), and should "slow up" opposite the station until her signal is responded to. When practicable the boat will be boarded in the stream by the inspector from his launch or yawl; but when necessary the vessel shall land at the station. The signal requiring a vessel to land will be made by dipping the station-flag, or (if at night) by waving a yellow light.

10. After examining the original certificate, the inspector will ascertain what, if any, changes have been made in the *personnel* or cargo since the last inspection; and will then make such examination of the boat as may be necessary to determine her present sainitary condition—being governed by Rule 5, *et seq.*, so far as applicable, in the treatment of a foul vessel. He will indorse the results of his inspection (and his action, if any) upon the original certificate, and make a record of the data called for in Form 3.

11. Boats (as described in Rule 1) departing northwise from, or entering the Mississippi River at, any point above New Orleans during the inspection season should be inspected at the nearest inspection station above such point, and furnished with certificates (Form 1), and in all other respects treated in the same manner as vessels from New Orleans.

12. Any boat, not included or defined in the above rules, may be boarded and inspected at any station in the discretion of the inspector; and if found so foul or infected as to be dangerous to health, she shall be treated in accordance with Rules 5 and 8. In the event of refusal to cleanse or disinfect, as required, the inspector will at once notify—by telegraph, if necessary—the authorities of ports which might be endangered by intercourse with such boat. Refusal to permit boarding and inspection will be deemed *prima facie* evidence of such a suspicious condition as to warrant exclusion; and notice, as above, shall be given in such cases.

13. At the port of departure, as well as at the intermediate stations, inspectors will endeavor to discharge their duties with the least possible delay or hinderance to the boat. To this end, inspectors above New Orleans will, when practicable, make their examinations while the boats are under way, the inspection launch or yawl accompanying the boat as far as may be necessary for this purpose.

14. No fee, charge, perquisite, or emolument whatsoever shall be received from boats inspected nor from the persons thereon, by the inspector or any other person connected with this service. Actual cost of disinfectants necessarily used or furnished for a foul or infected boat shall, however, be defrayed by the master or owner of such boat; and the inspector will, in all cases, receipt to said master or owner for any sum or sums thus received (Form 4).

15. Inspections of south-bound boats may be provided for hereafter, when in the judgment of the National Board such inspections are deemed necessary for the protection of the lower valley from the introduction of contagion or infection from above. Under such circumstances needed specifications of this code will be duly promulgated by the Board.

16. Inspectors will make weekly reports on the blanks furnished for that purpose (Form 3), and address the same to the secretary of the National Board of Health, Washington, D. C.

CODE B.

Rules and regulations to be enforced when yellow fever exists at or in the vicinity of any or place on the Mississippi River.

SECTION I.—AT THE PORT OF DEPARTURE.

1. When a port or place on the Mississippi River is declared by the National B of Health to be infected by yellow fever, and commercial intercourse is to be kep with such port or place, an inspector or inspectors will be detailed for duty to c out the provision of this code.

2. No steamboat or vessel of any kind shall leave such infected port for any o port or place in the United States without complying with these rules.

3. The master or owner of any boat about to leave an infected port shall notify inspector, in writing, at least twenty-four hours before the time set for taking on ca or for receiving passengers or baggage (Form 5).

4. Prior to the time appointed for receiving passengers and cargo the inspector w make a thorough examination of the boat and her officers and crew. If she is fou to be in good sanitary condition, clean and dry, free from untreated decaying wo and from all known sources or suspicion of contagion or infection, and if there be sickness among the officers and crew, the inspector will issue his permit to recei passengers and cargo (Form 6). Until said permit is issued, no passenger nor arti of baggage or of cargo should be received on board.

5. Careful inquiry will be made as to all persons engaged on the boat in any capa ity, and if it shall be found that any one of them has been exposed to the infection yellow fever, or has brought on board anything suspected of being infected, such pe son and such thing shall be removed from the boat, the thing disinfected and the pe son kept under observation for a period of not less than five days, unless he present satisfactory evidence that he has been protected by a previous attack of yellow feve

6. The attention of the captain or master will be directed by the inspector to th personal cleanliness of the crew, to the condition of their quarters, and to their foo and drinking water. If any one on board fall sick during the stay in port, he shoul be immediately removed to hospital.

7. None of the crew should be permitted to sleep on deck at night during the sickl season, and this should be guarded against especially while the boat is lying at malarious or infected places.

8. In no case should any passenger or article of baggage or of cargo be taken on board until the inspection above directed has been made and the sanitary condition of the boat has been found satisfactory. In case of violation of this rule, the inspector may withhold his certificate.

9. Neither persons nor things of any description, known or suspected to be infected, shall be received on board; and, during the loading of the boat and up to the time of departure, the inspector shall remain on duty to note the reception of any such suspected or infected person or thing.

10. Every passenger leaving an infected port or place shall obtain from the local health authorities a personal certificate of freedom from contagion or infection (Form 7). On presentation of such certificate, the inspector will examine the passenger, and, if satisfied, he will fill out the certificate of the National Board of Health (being part of Form 7), and will make a record of the information called for in Form 8, a duplicate of which will be furnished to the vessel.

11. Articles known or suspected to be infected shall not be received as cargo; and the inspector may, in his discretion, require the owner or shipper of any article or package offered for transportation to sign the declaration of agreement (Form 9).

12. Whenever a steamboat or other vessel is found to be infected, it shall proceed to the nearest quarantine station, or to some isolated location, there to be cleansed and disinfected. In the event that no quarantine station or suitable location is near at hand, or should the master or captain of the boat refuse to comply with these rules and regulations, the inspector will telegraph the facts to the nearest inspection station, and to the health authorities of the intermediate ports or places at which the boat or vessel might attempt to land.

13. When the National Board of Health declares a port to be *dangerously infected*, steamboats or vessels shall be disinfected within twelve hours before departure therefrom; and shall transfer passengers, baggage, and cargo at a point indicated in the special instructions issued to meet such emergencies.

14. The foregoing rules having been complied with, and the passengers and cargo being all on board, the inspector will furnish the captain or master with a bill of health (Form 10) certifying the precautions which have been taken and the danger to be apprehended, if any, from the boat, her passengers, officers, crew or cargo.

SECTION II.—DURING THE VOYAGE.

1. It is especially enjoined upon captains or masters, and other officers, of boats plying upon the Mississippi River during the existence of an epidemic, that they secure the utmost attainable cleanliness in every part of their boats. The bilge should be pumped out every day, and fresh water run in until it is discharged clean and free from odor and discoloration; the hold should be well ventilated, and all refuse matter of every description should be promptly disposed of; all decaying wood should be scraped and painted with zinc and turpentine until it is completely saturated; lime-wash and copperas of zinc-iron should be freely used in the hold and bilge, on and about the boiler-deck and in water-closets and urinals; soap and hot water should be freely used; cabins, state-rooms, and "texas" should be sunned and aired at least six hours each day, weather permitting, as well as all clothing, bedding, carpets, and upholstered furniture. Sun and air are the best, as well as the cheapest, disinfectants. Freely and frequently expose every possible portion of the vessel and its contents to their action, and supplement this by scrupulous and thorough cleanliness.

2. Should sickness make its appearance on board, a sick-bay or hospital should be established as near the stern of the boat as possible, and preferably upon the boiler-deck. The patient must be removed at once to this place, the necessary attendants appointed, and all other persons rigidly excluded from the vicinity of the sick. The attendants must be confined to the hospital quarters and not allowed to mingle with others of the passengers or crew.

3. Immediately after the removal of the patient to the sick-bay, his state-room and its contents must be disinfected with sulphurous acid gas. This is done by burning a couple of pounds of coarsely powdered brimstone in an iron vessel upon the floor of the room—proper precautions being taken against accident by fire. The room must be kept tightly closed after the brimstone is ignited, and not opened again until arrival at the inspection station. At least one room on either side of this room must be vacated during the rest of the trip.

4. During the existence of yellow fever, *all cases of fever* are to be regarded with suspicion. If such cases occur during a voyage, they must be isolated and the same precautions taken as if they were known to be yellow fever.

5. The master or captain shall keep, or cause to be kept, a record of any sickness which may occur on board during the trip. Such record shall set forth the name of each sick person, the hour and day when taken ill, and the symptoms, together with the changes in his or her condition during the morning, afternoon, and night of each day. It shall also state what precautions have been adopted and carried out. This record shall be presented to the inspector on arrival at the station.

SEC. III.—AT LANDING PLACES AND INSPECTION STATIONS.

1. Upon the arrival of a boat from an infected port near, the bill of health (Form 10), and a statement from the captain (Form 11), shall be submitted to the health authority, under such precautions as may be deemed necessary. It is recommended that this be done at some convenient place not nearer than one mile from the limits of the port, and that the bill of health and the captain's statement be examined before boarding the boat.

2. If, upon examination, the bill of health and the captain's statement are found to be in proper form and satisfactory, the boat shall then be boarded and examined; and if her condition and that of her cargo, passengers, officers and crew, be found to correspond with the representations in said bill of health and statement, and there be found no sickness of a doubtful or suspicious nature on board, the boat will be authorized to land and to have free intercourse with the port or place; subject, however, to such additional requirements as may be prescribed by the local authorities, and not in conflict with these rules and regulations.

3. Until authorized as above, no boat clearing from, or having touched at, an infected port shall land at any other port or place; and this regulation will be enforced by such measures (of fine and penalty) as the local authorities may decree.

4. When suspicious sickness is found on board, or the condition of the boat or its contents (persons or things) is, in any other respect, adjudged to be dangerous to the public health, she shall proceed forthwith to the nearest inspection station for treatment. Local authorities cognizant of the movements of such boat will telegraph the facts to the nearest inspection station and to adjacent ports.

5. A boat approaching an inspection station should give her usual signal (by whistle), and "slow up" until her signal is responded to. When practicable, the vessel will be boarded in the stream by the inspector, from his launch or yawl; but, when necessary, the vessel shall land at the station. The signal requiring a vessel to land will be made by dipping the station flag by day, and by waving a signal light at night.

6. After examining the bill of health and the captain's statement, the inspector will ascertain what, if any, changes have been made in the *personnel* and cargo of the

vessel since the last inspection, and will then make such critical examination of vessel as may be necessary to determine her present sanitary condition.

7. If the vessel be found free from doubtful or suspicious sickness, clean and good sanitary condition, the inspector will so indorse the bill of health, and she v be authorized to proceed upon her trip.

8. Especial attention will be paid to the examination of such passengers, bagga cargo, or freight as may have been taken on board subsequent to the last inspecti and the inspector will note all additions of passengers upon the passenger list (Fo 8), and will furnish them with personal certificates (Form 12).

9. If the vessel is found to be infected, she will be at once removed to a suitable lo tion, and treated as follows:

(*a*) The sick will be removed to hospitals for treatment. Other passengers, and t unprotected or susceptible among the officers and crew, will be removed to quart prepared for their reception. Only "protected" persons (in the sense of those w have previously had an attack of typical yellow fever) shall be allowed on the ves until after she has been disinfected.

(*b*) No article of clothing, bedding, or personal baggage of any description fro the vessel shall be taken into hospitals or quarters until such article has been tho oughly disinfected.

(*c*) After the removal of persons and baggage, the boat shall be disinfected b means of sulphurous acid gas, as thoroughly as possible, without disturbing th cargo. The crew of the boat shall then discharge the cargo, which shall be store in such manner as to insure its freest exposure to the open air consistent with neces sary protection.

(*d*) When the cargo has been removed, the vessel shall be thoroughly cleansed ir every accessible part, again disinfected and ventilated as the inspector may deem necessary. After the preliminary disinfection (prescribed in article "*c*"), all work in removing and handling cargo and in cleansing and care of boat should be performed by the crew under the direction of the inspector.

10. Until this process of discharge of cargo and purification of boat, as above directed, has been completed to the satisfaction of the inspector (as shown by his certificate to that effect) there shall be no communication between the boat and the shore, or with other vessels, except by the written permit of the inspector, and then only in the manner and for the purpose specified in said permit.

11. Those sick with yellow fever shall not be allowed to leave the hospital until in the judgment of the inspecting officer they can do so without danger to themselves or others.

12. Persons under observation shall be detained for at least five days from the time of last exposure to the contagion or infection of yellow fever. If the disease appears among such persons the sick shall be removed to hospital, and a new locality for observation selected with such precautions, by way of disinfection, &c., as the inspector may deem necessary to prevent the transportation of the infection to the new site.

13. No arbitrary period of detention, beyond five days from last exposure of unprotected persons, will be enforced. The vessel will be permitted to depart, and the cargo released as soon as the inspector deems it safe to do so with reference to the public health.

14. "Protected" persons, whether among the passengers, officers, or crew, shall be exempt from the five days' detention for observation, and may be allowed to depart at any time after the necessary precautions have been taken with regard to their baggage, clothing, and other effects, as well as to themselves in person. The inspector shall be the judge of the evidence of such "protection," and will exercise due caution in the use of this discretionary power.

15. When the boat and cargo are released the inspector shall issue his certificate, reciting the facts in relation to said boat, his action thereupon, and his belief that the boat and cargo are free from infection, and may proceed without danger or menace to the public health.

16. No person taken from an infected boat at the inspection station shall depart therefrom without a certificate from the inspector authorizing him or her to proceed, as being free from infection or the probability of conveying the same.

17. Persons employed at an inspection station, having been brought in contact with an infected boat, shall not be permitted to leave such station until their clothing has been washed and disinfected.

18. It shall be the duty of the inspector to take such other measures of precaution, in addition to the foregoing, as he may deem necessary or expedient for the protection of the public health.

19. No boat nor passenger having the proper certificates showing that these rules and regulations have been complied with, should be detained by other health authorities, except for sufficient cause.

20. The foregoing regulations apply to all boats carrying passengers or freight, including all tow-boats, tugs, barges, and canal-boats plying upon the Mississippi River south of Cairo, Ill.

[Form 1.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 188 .

Certificate of inspection of the ——, 188 .

EXPLANATIONS.

1. The master or captain of the boat will fill up and sign blank A.
2. Every person on board at time of inspection must be accounted for, either among the passengers, officers, or crew.
3. Only the following articles of cargo need be specified: Coffee, sugar, fruits, other articles from tropical ports, second-hand bedding and clothing, rags, and paper stock.
4. If the vessel is a tow-boat the number, names, and tonnage of her barges will be given in the space for cargo. If the barges are loaded, articles of cargo enumerated above will be specified.

DECLARATION OF CAPTAIN, A.

[To be sworn to if required.]

PORT OF ——, ——, 188 .

I do hereby declare that the following statements concerning the vessel herein named (whereof I am captain or master), and concerning her present trip, are correct and true to the best of my knowledge and belief, to wit: The ——, built in the year ——, burden —— tons, leaves —— this —— day of —— 188 , bound for ——, carries —— officers, —— crew, —— cabin and —— deck passengers, no one of whom is known or suspected to have yellow fever, cholera, small-pox, or plague, or to have been recently exposed to either of these diseases. Her cargo comprises —— ——.

—— ——,
Captain.

Sworn and subscribed to before me this —— day of ——, A. D., 188 .

—— ——,
Inspector.

NATIONAL BOARD OF HEALTH—CERTIFICATE OF INSPECTION, B.

No·——.] PORT OF NEW ORLEANS, LA.,
—— —, 188 .

I certify (1) that I have this day inspected the ——; (2) that I find her sanitary condition satisfactory; (3) that her passengers, officers, and crew are apparently free from contagion or infection; (4) that the rules and regulations of the National Board of Health have been complied with ——; and (5) that the character of her cargo is unobjection ——.

The vessel is hereby authorized to proceed upon her trip.

—— ——,
Inspector.

NATIONAL BOARD OF HEALTH—CERTIFICATE OF INSPECTION, C.

No. ——.] STATION NO. 1, near VICKSBURG, MISS.,
—— —, 188 .

I certify that I have this day inspected the ——, and find that the statements made in the declaration of the captain (A), as also those numbered ——, in the preceding certificate (B) agree with the present condition of the vessel, her passengers, officers, crew, and cargo, with the following exceptions: —— ——

The rules and regulations of the National Board of Health having been fully complied with, and the sanitary condition of the vessel, her passengers, officers, crew, and cargo being satisfactory, she is hereby authorized to proceed upon her trip.

—— ——,
Inspector.

NATIONAL BOARD OF HEALTH—CERTIFICATE OF INSPECTION, D.

No. ——.] STATION No. 2, near MEMPHIS, TENN.,
—— —, 188

I certify that I have this day inspected the —— ——, and find that the stat ments made in the declaration of the captain (A); those numbered ——, in certific B, and those in certificate C, agree with (remainder of form same as that of C).

NATIONAL BOARD OF HEALTH—CERTIFICATE OF INSPECTION, E.

No. ——.] STATION No. 3, near CAIRO, ILL.,
—— —, 188 .

I certify that I have this day inspected the —— ——. and find that the stat ments made in the declaration of the captain (A); those numbered 2, 3, 4, and 5, certificate B, and those in certificates C and D, agree with (remainder of form san as C).

[Form 2.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE.

PORT OF NEW ORLEANS, LA.,
—— —, 188 .

The inspector of the National Board of Health—River Inspection Service—is hereby notified that the —— is on berth at ——, and will leave for —— at — o'clock — m., ——, 1880.

—— ——,
Captain.

[Form 3.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE.

Record of inspections made at —— during the week ended ——, 188 .

—— ——,
Inspector.

NOTE.—Inspectors at intermediate stations will note in their records (under the heads of "found on board" and "cargo") any changes made during the trip in passenger list or cargo. They will specify (under the head of "Remarks") what, if any, inspections have been made during the trip of each vessel prior to her arrival at their respective stations, and note any special features of such inspections.

They will also (under the same head) state fully what measures of cleansing or disinfection may have been found necessary and enforced by them.

[Form 3 continued.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE.

Record of inspection No. —, made ——, 188 , — o'clock — m.

—— ——,
Inspector.

Inspected ——; built, —— tonnage ——; —— ——, captain.
Bound from ——, ——, 188 , to ——.
Found on board: — officers, — crew, — cabin, — deck passengers ——
Cargo comprises the following articles duly specified on certificate:——
Condition of vessel: Hold, ——; bilge, ——; water closets and urinals, ——; decaying or rotten wood, ——; quarters for crew, ——;
Remarks: (four blank lines.)

[Form 4.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 188 .

Received ....
from ....
....
$ · 100 for
....
....
....

STATION No. —, near ——, —— 31, 188 .

Received from —— ——, captain of the ——, the sum of —— dollars, in full for disinfectants (kind and quantity specified on the back hereof) furnished for the cleansing and disinfection of said vessel.

—— ——,
Inspector.

$ 100

[Form 5.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 188 .

PORT OF (1) ——, ——.,
——, 188 .

The inspector of the National Board of Health, river inspection service, is hereby notified that the (2) ——, whereof the undersigned is master, is on berth (3) ——, for (4) ——, and will be ready to receive passengers, baggage, and freight on board at (5) ——, 188 .

(6) —— ——, *Master.*

NOTE.—Fill out blanks with (1) name of port and date of notice; (2) name of vessel; (3) location of berth; (4) place of destination; (5) hour, a. m., or p. m., and day of week and of month of departure; (6) signature of master, for whom the clerk of the boat may sign.

(Indorsement:) Form 5, 188 . National Board of Health. River inspection service. Notice to inspector.

[Form 6.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 188 .

PORT OF ——, ——,
——, 188 .

I have this day inspected the ——, ——, master, bound for ——, ——, from this port; and do hereby certify that her sanitary condition ——; that the hold ——; that the bilge ——; that there is —— decaying wood ——; and that her officers and crew show —— symptoms of yellow fever, and are believed —— to have been exposed to that disease within the past —— days.

The said vessel, being hereby pronounced free from all known sources of contagion or infection ——, is authorized to receive passengers, baggage, and cargo, in accordance with the rules and regulations of the National Board of Health.

—— ——,
Inspector.

(Indorsement:) Form 6, 188 . National Board of Health. River inspection service. Permit to receive passengers and cargo.

[Form 7.]

NATIONAL BOARD OF HEALTH—PASSENGER'S CERTIFICATE AND INDORSEMENTS, 188 .

[Size 6 inches wide, 10 inches long, to fold twice, making 6 pages.]

CERTIFIED STATEMENT OF PASSENGER.

I do hereby certify that I have not, w
——, nor in any manner exp

during all of said period at No. — ——— street, and that I desire to proceed by to ———.

In witness whereof I have hereunto set my hand and seal the day and date a written.

[L. S.] ——— ———

VERIFICATION OF PHYSICIAN.

——— ———, the person whose signature is appended to the above certificat personally known to me, and I believe the statements made in said certificate t true and correct. I further believe [him or her] to be free from contagion or infect and that [he or she] may proceed upon [his or her] journey without injury or da to the public health.

——— ———, *M. I*

———, ———,
——— —, 188 .

LOCAL AUTHORIZATION.

BOARD OF HEALTH OF ———, ———,
——— —, 188 .

——— ———, M. D., a reputable practicing physician, having proper opportunit for knowing the present conditions affecting the public health, and believed to ful recognize the importance of preventing the spread of the existing epidemic, is here authorized and empowered to verify the foregoing certificate.

——— ———,
President Board of Health.

NOTE.—In the absence of a board of health, the chief municipal officer will iss this authorization.

I hereby certify, after personal examination, that ——— ———, named in th within certificate, is not now affected with ———; that all rules and regulations o the National Board of Health relating to the departure of passengers from infecte towns and places, have been complied with in [his or her] case; and that [he or she may, without danger to the public health, proceed as a passenger on the ——— t ———, ———.

——— ———,
Inspector, N. B. H.

———, ———,
——— ———, 188 .

INDORSEMENTS OF SUBSEQUENT INSPECTORS.

——— ———. ——— ———.
——— ———. ——— ———.
——— ———. ——— ———.

[Form 8.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 188 .

Passenger list of the ———, ——— ———, *master, from the port of* ———, ———, *this* ——— *day of* ———, 1880, *to* ——— ———.

Name.	Last residence.	Where to.	Name of physician verifying certificate.

NOTE.—If the sex is not indicated by the name prefix *Mrs.* or *Miss* in the proper cases. Add the letter "*c*" after the names of colored persons. The number, street, and city or town, will be given under the head of "Last residence." The inspector will add, after the last name, the following: Personally examined the above-named passengers, and authorized their departure.

(Signature.)
Inspector.

(Indorsement:) Form 8. 188 . National Board of Health. River inspection service. Passenger list.

[Form 9.]

DECLARATION AND AGREEMENT.

PORT OF ——, ——,
——, 188 .

I, —— ——, a resident of ——, ——, and being the legal and rightful owner custodian (1) of certain property, to wit: (2)

....

and being desirous of shipping the same, by the ——, from this port to ——, ——, do hereby declare that said described property has not been exposed to any contagion or infection of —— —— within the past —— days, to the best of my knowledge and belief, and that the contents of the packages are as herein described.

I do, further, hereby agree to submit said property to the rules and regulations of the National Board of Health relative to the spread of epidemic, contagious, or infectious diseases.

In witness whereof I have hereunto set my hand and seal, at the port and on the day and date above written.

[L. S.] —— ——.

NOTE.—(1) Strike out the superfluous word.—(2) Describe the contents of packages (boxes, barrels, bales, etc.), and give the shipping marks and address.

(Indorsement:) Form 9, 188 . National Board of Health. River inspection service. Declaration and agreement of shippers.

[Form 10.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 188 .

BILL OF HEALTH.

I do hereby certify that I have this day personally examined the vessel herein named, and find the following to be the essential facts bearing upon the relation of said vessel to the public health:

Name and description: ——.
Built at ——, ——; in the year 18—.
Tonnage: ——. Destination: ——.
Name of captain: ——.
Total No. officers and crew, (1) —— ; cabin passengers (2) ——; deck passengers (2) ——. Total souls on board ——.
Cargo: (3) ——.
Condition of hold: ——; of bilge ——; of passenger's accommodation: ——; of crew's quarters: ——; of water-closets and urinals: ——; of other specified portions of the vessel: ——.
Condition of persons on board: ——.

The rules and regulations of the National Board of Health, relative to the spread of epidemic, contagious, or infectious diseases at the port of departure, having been fully complied with, and the vessel and her contents being believed to be free from contagion and infection, she is hereby authorized to proceed to her port of destination, subject to the further rules and regulations governing vessels in transit and on arrival at landing places and inspection stations.

In witness whereof, I have hereunto set my hand and seal at the port of ——, ——, this —— day of ——, A. D. 188 .

[L. S.] —— ——,
Inspector, N. B. H.

NOTE.—(1) All persons employed on board, in whatever capacity, must be accounted for. (2) The names of all passengers must appear on the passenger's list, Form 8. (3) Articles of cargo shipped under declaration and agreement, Form 9, must be mentioned on this bill of health.

(Indorsement:) Form 10. 188 . National Board of Health. River inspection service. Bill of health.

[Form 11.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 188

ON BOARD ——,
Near ——, ——

I, —— ——, master of the above-named vessel, do hereby certify that the no yellow fever on board, and no infected article or cause of contagion of any kin the best of my knowledge and belief. All the rules and regulations of the Nati Board of Health, relative to the prevention of the spread of epidemic, contagious, infectious diseases, have been complied with.

Since last being inspected I have made the following landings:

....

In witness of the truth of the foregoing statement I have hereunto set my hand seal, this —— day of ——, A. D. 188 .

[L. S.]

—— ——,
Master

(Indorsement:) Form 11. 188 . National Board of Health. River inspecti service. Statement of captain or master.

[Form 12.]

NATIONAL BOARD OF HEALTH—RIVER INSPECTION SERVICE, 188 .

INSPECTION STATION NO. —, near ——,
—— —, 188 .

I hereby certify that the bearer of this certificate, —— ——, arrived at this sta tion on the ——; that the passenger-list of said vessel shows [him or her] to hav been received on board at ——, which place is now free from yellow fever; that [h or she] is not now affected with that disease; is believed to be free from contagion o infection; and may, without danger to the public health, proceed to ——.

—— ——,
Inspector.

(Indorsement:) Form 12. 188 . National Board of Health. River inspection service. Way passenger service.

Rules and regulations for the conduct of railway travel and traffic in regions exposed to or infected by yellow fever.

GENERAL RECOMMENDATIONS AT ALL SEASONS OF THE YEAR.

1. The depots, buildings, and surroundings should be kept clean, the grounds well drained, and free from stagnant water and decomposing organic matter; the water-closets and privies thoroughly clean in every part, and free from offensive odors; the vaults of privies emptied often enough to prevent any large accumulation of excrement or offensive matter, and kept disinfected by the use of saturated solutions of the sulphates or chlorides of iron or zinc, in sufficient quantity to remove all offensive odors.
2. The road-beds and tracks of railroads should be kept free from filth and impurities. It is especially desired that this rule be observed in respect to all sidings near stations or towns.
3. The upholstered seats of passenger and sleeping cars, and the mattresses, pillows, blankets, curtains, and carpets of sleeping-cars should be thoroughly whipped or beaten (in the open air so far as practicable) and brushed free from all dust, and thoroughly aired and sunned at the end of each trip.
4. So far as practicable, woolen upholstery, curtains, and carpets should be dispensed with in passenger, sleeping, and parlor coaches on all lines south of the Ohio River between April 1 and November 1 each year. During this period, if seats must be used which are upholstered with woolen stuffs, they should be protected by linen covers, which should be washed at the end of each trip.
5. Especial attention should be paid to the condition of the closets, as also of the water supply for drinking purposes.
6. All railroad cars should be thoroughly ventilated at all times.

Rules and regulations recommended to be enforced by State or municipal authorities during the existence of yellow fever.

1. Every train leaving an infected city, town, or other place shall be inspected by a competent medical man, who shall give to the conductor of said train a certificate of the results of his inspection in accordance with Form No. 1, appended hereto.

2. It shall also be his duty to furnish certificates to each passenger, in accordance with Form No. 3, appended hereto, and no passenger shall be permitted to leave an infected place without such certificate. No person having fever shall be allowed to take passage on such train.

3. All cars leaving such place shall be thoroughly cleansed, and fumigated with sulphurous acid gas by burning 18 ounces of sulphur for every 1,000 cubic feet of space, closing the car tightly for six hours prior to leaving.

4. No upholstered car shall be allowed to leave a dangerously infected place; but passengers shall be carried from such place to the transfer station (provided for in Rule 6) in open pavilion cars, or cars furnished with wooden seats and with such facilities for ventilation as will insure thorough exposure to the open air during the transit.

5. All baggage shall be thoroughly disinfected at or near the station before leaving.

6. At a point not less than five miles, and as near this distance as practicable, from the point of departure from an infected place, there shall be an entire transfer of passengers and baggage to other open pavilion cars of the same description as those prescribed in Rule 4, which cars shall not enter an infected district except as provided for in Rule 16.

7. The transfer train from an infected place, after having disembarked its passengers and baggage at the transfer station, shall withdraw, with its conductor and crew, at least one mile before the outbound train will be allowed to back down to the station. Both trains must not be permitted to be at the station at the same time, and the officer in charge of the transfer will allow no communication between the crews of the respective trains.

8. This transfer shall be made in the open air, under the supervision of a medical officer, and as far from a habitation as possible, and no person with fever shall be allowed to proceed. Neither shall any person be allowed to proceed without the certificate (Form 3) prescribed by Rule 2.

9. The medical officer at the transfer station shall carefully examine the conductor's certificate (Form 1), and the certificate of each passenger (Form 3), and shall fill up the blanks in the transfer-station certificate attached to Form 3, and furnish to the conductor of the outbound train his certificate (Form 2) duly made out to accord with the results of his examination.

10. The pavilion cars from the transfer station may be attached to the rear of any regular train at a point not less than five miles beyond the station, and passengers and baggage from such pavilion cars may enter the regular passenger and baggage cars of such regular train after having been carried in the pavilion cars for a distance of not less than fifty miles from the infected place, but not sooner.

11. No sleeping-car shall be allowed to leave a dangerously infected place, nor shall any sleeping-car approach nearer such place than a point five miles beyond the transfer station.

12. In case of suspected infection of a passenger-car, or of a sleeping-car, such car, including all the upholstery, cushions, curtains, mattresses, &c., shall be thoroughly disinfected, under the supervision of a medical officer, and shall be exposed to the open air for at least twenty days before being again used.

13. All freight shall be transferred at a point not less than five nor exceeding fifty miles from the point of departure, and the cars from which such freight has been transferred shall not proceed farther on the road, but shall be returned to the point of departure. The freight cars, after unloading, shall be thoroughly cleansed by scrubbing, disinfected, and ventilated

14. Mail matter and mail bags shall be heated to a temperature of two hundred and fifty degrees Fahrenheit, or should be otherwise disinfected before they are sent from infected places.

15. If yellow fever infect a place situated upon a line of railroad, trains of all kinds may be permitted to pass through without stopping, and at a speed of not less than ten miles an hour; but they shall not take on passengers from such infected place except as hereinbefore provided—namely, after transit of person and baggage (in such manner as shall secure free exposure to the open air) from the infected place to a point at least five miles distant, where, upon presentation of the proper certificate (Form 3), they may be received on the pavilion cars provided for such purpose, but from which they shall not enter the regular cars of the train until after having ridden at least fifty miles from the infected place.

16. No train having a certificate of inspection from a transfer station (Form 2), and

no passenger having certificate (Form 3) duly *visé* at the proper transfer stat shall be interfered with by any municipal or other local system of quarantine.

17. All persons leaving infected places by other modes of travel than those he provided for shall be required to obtain certificates according to Form 4, appen hereto.

[Form No. 1.]

I hereby certify that train No. —, on the —— Railroad, —— ——, conduct and which leaves —— at — o'clock — m., this day, has complied with all the ru and regulations recommended by the National Board of Health for trains leaving i fected places.

—— ——, (signature)
Inspecting Officer.

(Name of place.)
(Date.)

[Form No. 2.]

I hereby certify that train No. —, on the —— Railroad, —— ——, conductor, has not been nearer the city (or town) of —— than — miles; that the passengers and baggage thereon were brought to this station in open pavilion cars, and that all the rules and regulations recommended by the National Board of Health for the conduct of railway travel and traffic with infected places have been complied with by this train, which is, therefore, authorized to proceed without further detention.

(Name of transfer station, date, and signature.)

[Form No. 3.]

(Same as "Form No. 2," of 1879.)

[Form No. 4.]

(Same as "Form No. 3," of 1879.)

(Matter on pp. 29, 30, 31, and 32, pamphlet of 1879, unchanged. To "General Explanations," on p. 31, add the "Explanations" on p. 4, *ibid.*)

Rules and regulations to be observed and enforced by the health authorities of a place free from infection, having communication with a place dangerously infected with yellow fever.

1. No steamboat or other vessel, or railroad train or other conveyance, or persons, from a place *dangerously infected*, shall be permitted to enter a non-infected place without having certificates of the forms prescribed, giving evidence that they have complied with the rules and regulations provided for conveyances and persons leaving *dangerously infected* places. Boats, trains, and persons having certificates in proper form that they have been inspected and are free from disease shall be allowed to enter.

2. Inspections to ascertain whether these rules have been observed, and whether it is safe for the conveyances or persons to enter a non-infected place, shall be made outside the limits of such place.

3. Separate accommodations must be provided both for the sick and for the well who are detained for observation.

Rules and regulations recommended to be adopted and observed when yellow fever is reported or suspected to exist in any town or place in the United States.

GENERAL EXPLANATIONS.

A. During the warm season, in all localities in any way exposed to contagion of yellow fever, the possibility of its occurrence should never be lost sight of by physi-

cians, and when it is known to be present in any place, the antecedents and diagnosis of every case admitting of doubt should receive special attention.

B. Upon an outbreak of yellow fever, a competent medical officer should be assigned to the locality as health officer, to enforce the following rules and regulations:

1. All physicians shall report to the health authorities with the least possible delay their knowledge or belief of the existence of the first cases of yellow fever, and shall at the same time secure, as far as possible, the isolation of such cases pending the action of the health authorities.

2. Upon the receipt of such report the health authorities shall at once investigate the case, and if it be found to be yellow fever or a case admitting of reasonable doubt, they shall at once have the patient isolated as effectually and completely as possible.

3. In case of the patient's removal, recovery, or death, the premises occupied by him shall be thoroughly disinfected, and the clothing, bedding, and other articles which have been exposed to infection shall be either burned or boiled in water for not less than thirty minutes.

4. When the health authorities of any place shall first discover a case of yellow fever there, they shall report the fact at once by telegraph to the National Board of Health.

5. An attempt should be made to isolate and keep under observation for at least five days all persons who have been in such relation to the first case or cases as to make it possible that they are infected.

6. In general, no place shall be considered *dangerously infected* until at least one case has occurred as a result of infection incubating within the place itself.

7. When a place is declared *dangerously infected* the health authorities should advise, and use every effort for, the removal of all persons liable to yellow fever to a place or places safe from danger of infection. When they can be removed to only a short distance, it is better to locate them in tents in the open air.

[From Bulletin No. 46, May 15, 1880.]

ANNUAL MEETING OF THE NATIONAL BOARD OF HEALTH.

The annual meeting of the National Board of Health was held in the city of Washington, D. C., covening on May 4 and adjourning on May 10, 1880.

The Board re-elected its former officers, and revised its by-laws and appointed committees, as follows:

BY-LAWS OF THE NATIONAL BOARD OF HEALTH.

1st. The officers of the National Board of Health shall consist of a president, vice-president, and secretary.

2d. There shall be an executive committee, composed of the president, vice-president, secretary, and three other members.

3d. The officers of the Board and the other members of the executive committee shall be elected by ballot at the first annual meeting in each year, the nomination to be by informal ballot.

4th. The duties of the president shall be—

First. To preside at all meetings of the Board and of the executive committee.

Second. To call meetings as provided in the act creating the Board.

Third. To make requisitions upon the Secretary of the Treasury for such sums as may be directed by the Board.

5th. The vice-president shall take the place and perform the duties of the president when absent.

6th. The secretary shall keep the records and conduct the correspondence of the Board and of the executive committee, certify to the correctness of all vouchers for expenditures, and perform such other duties as the Board or executive committee may from time to time direct, and he shall be the custodian of all papers, books, and other property of the Board.

7th. The executive committee shall carry into effect the directions of the Board, and act for it during the intervals of its sessions, reporting such action to the next meeting.

8th. The executive committee is authorized to fill any vacancies in the offices or executive committee occurring in the intervals of the meetings of the Board, such election to hold good until the close of the next meeting of the Board.

9th. No purchases shall be made or expenditures incurred except by order of the Board or of the executive committee, and the executive committee shall not have power to incur any indebtedness beyond the amount of funds authorized by the Board

to be drawn by the president, and placed to the credit of the Board with the disbursing agent.

10th. The executive committee shall be considered to be in permanent session, and in the interval of the regular meetings, any three members, of whom the secretary shall be one, shall constitute a quorum, and be authorized to transact any business provided there be a concurrent vote. In case of disagreements the secretary shall be required to report the fact to the absent members and solicit an expression of their wishes as to the call of a formal meeting of the whole committee, or as to taking a vote by correspondence.

11th. All bills for salaries and expenses shall be duly certified by a member of the Board or an inspector and audited and approved by the secretary of the Board, who shall keep an accurate record of such vouchers and approvals.

12th. The standing committees of the Board shall be as follows, each to be composed of not less than three members, named by the president, with the exception of that on epidemic and contagious diseases, which shall consist of five members:

1. On epidemic and contagious diseases.
2. On registration and vital statistics.
3. On State, municipal, and local sanitary legislation.
4. On quarantine legislation—State, national, and international.

13th. The regular meetings of the Board shall be semi-annual, in June and December of each year, at a day and place to be fixed by the executive committee.

14th. The president shall call a meeting of the Board whenever five members make in writing or by telegraph a joint request to him to that effect.

THE NATIONAL BOARD OF HEALTH.

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4. *On quarantine legislation—State, national, and international.*—S. Smith, S. F. Phillips, J. L. Cabell, S. M. Bemiss, P. H. Bailhache.

[From Bulletin No. 51, June 19, 1880.]

RULES AND REGULATIONS FOR SECURING THE BEST SANITARY CONDITION OF VESSELS, INCLUDING THEIR CARGOES, PASSENGERS, AND CREWS, COMING TO THE UNITED STATES FROM ANY FOREIGN PORT WHERE ANY CONTAGIOUS OR INFECTIOUS DISEASE EXISTS.

[Prepared by the National Board of Health, in accordance with the provisions of an act approved June 2, 1879, entitled "An act to prevent the introduction of infectious or contagious diseases into the United States."]

EXPLANATIONS.

1. The object of the following rules and regulations is to prevent the introduction into the United States of "contagious or infectious diseases."

2. The following diseases are recognized as "contagious or infectious diseases" for the purposes of these rules and regulations, viz: Asiatic cholera, yellow fever, plague, small-pox, typhus fever, and relapsing fever.

3. An "infected" port or place, in the sense of these rules, is a port or place at which either Asiatic cholera, yellow fever, or plague exists, or at which either small-pox, relapsing fever, or typhus fever exists as an epidemic.

4. To secure the "best sanitary condition" of a vessel the following points should be observed by the owners, agents, or master of such vessel:

A. Exclusion from the vessel, as far as possible, of persons or things known or suspected to be infected.

B. Cleanliness, dryness, and ventilation of the vessel, both preliminary to loading and during the voyage.

C. Disinfection—that is, the destruction or removal of the causes of disease—which includes measures of cleanliness, ventilation, fumigation, &c.

D. The crew shall not be allowed liberty on shore after nightfall in suspected localities. They shall not be allowed to sleep on deck except under awnings. The forecastle shall be well ventilated and kept dry. Both in port and at sea the bilge shall be pumped out each morning and evening, or more frequently if necessary. The utmost cleanliness shall be observed at sea as well as in port. Each seaman should have two suits of underclothing. The clothing and bedding should be aired every clear day. In tropical climates the men should be required to wash their persons and change their underclothing every evening after work while in port, and each working suit should be washed, dried, and aired after a day's use. These regulations as to clothing, airing of bedding, and ventilation, should, as far as possible, be observed at sea as well as in port.

RULES AND REGULATIONS.

1. All merchant ships and vessels sailing from a foreign port where contagious or infectious disease exists, for any port in the United States, must obtain from the consul, vice-consul, or other consular officer of the United States, at the port of departure, or from the medical officer—where such officer has been detailed by the President for that purpose—a bill of health in duplicate, which shall be a clean bill or a foul bill, and which shall set forth the sanitary history of said vessel, and that it has in all respects complied with these rules and regulations. A clean bill of health shall be given when neither Asiatic cholera, yellow fever, nor plague exists, and neither small-pox, relapsing fever, nor typhus fever exists as an epidemic at the port of departure, and the condition of the vessel is satisfactory; and in such case it shall be certified that the vessel leaves the port in "free pratique." A foul bill of health shall be given when either Asiatic cholera, yellow fever, or plague exists, and when small-pox, relapsing fever, or typhus fever exists as an epidemic at the port of departure, or where the sanitary condition of the vessel is unsatisfactory, and in such case it shall be certified that the vessel leaves the port in "quarantine."

2. In all cases of doubt as to whether the port is infected, or as to the sanitary condition of the vessel, the bill shall be foul.

3. No vessel shall have more than one bill of health; but if she touches at other ports on the passage, that fact and the condition of those ports as to the existence of contagious or infectious disease shall be indorsed upon the original bill of health by the consul, vice-consul, consular officer, or medical officer of the United States.

4. The bill of health shall be in the form appended. [Form A.]

5. Each consul, vice-consul, consular officer, or medical officer of the United States in a foreign port shall keep himself thoroughly acquainted with the sanitary condition of the port and its vicinity, especially with regard to the existence of contagious or infectious diseases, or epidemics, and shall upon request of the owner, agent, or master make, or cause to be made, an inspection of every ship or vessel bound for any port

in the United States, and give the bill of health required by these regulations. Vessels carrying a foreign flag shall be inspected, when practicable, in company with the consul or consular agent of the nation to which the vessel belongs.

6. The fee for such inspection shall be such as may be fixed by the Secretary of the Treasury in accordance with law.

7. The certifying officer at the port of departure shall certify whether vessels carrying passengers are provided with the means of carrying out the provisions of sections 4257 and 4263 of the Revised Statutes.

SEC. 4257. Every such vessel so employed in transporting passengers between the United States and Europe, and having space according to law for more than one hundred such passengers, shall have at least two ventilators to purify each apartment occupied by such passengers; one of which shall be inserted in the after part and the other in the forward part of the apartment, and one of them shall have an exhausting-cap to carry off the foul air, and the other a receiving-cap to carry down the fresh air. Such ventilators shall have a capacity proportioned to the size of the apartments to be purified, namely: If the apartments will lawfully authorize the reception of two hundred such passengers the capacity of each such ventilator shall be equal to a tube of twelve inches diameter in the clear, and in proportion for larger or smaller apartments. All such ventilators shall rise at least four feet six inches above the upper deck of any such vessel, and be of the most approved form and construction. If it appears from the report to be made and approved, as provided in section forty-two hundred and seventy-two, that such vessel is equally well ventilated by any other means, such other means of ventilation shall be deemed to be a compliance with the provisions of this section.

SEC. 4263. The master of any vessel employed in transporting passengers between the United States and Europe is authorized to maintain good discipline and such habits of cleanliness among passengers as will tend to the preservation and promotion of health; and to that end he shall cause such regulations as he may adopt for this purpose to be posted up, before sailing, on board such vessel, in a place accessible to such passengers, and shall keep the same so posted up during the voyage. Such master shall cause the apartments occupied by such passengers to be kept at all times in a clean, healthy state; and the owners of every such vessel so employed are required to construct the decks and all parts of the apartments so that they can be thoroughly cleansed; and also to provide a safe, convenient privy or water-closet for the exclusive use of every one hundred such passengers. The master shall also, when the weather is such that the passengers cannot be mustered on deck with their bedding, and at such other times as he may deem necessary, cause the deck occupied by such passengers to be cleansed with chloride of lime or some other equally efficient disinfecting agent. And for each neglect or violation of any of the provisions of this section the master and owner of any such vessel shall be severally liable to the United States in a penalty of fifty dollars, to be recovered in any circuit or district court within the jurisdiction of which such vessel may arrive or from which she is about to depart, or at any place where the owner or master may be found.

8. Every vessel before taking on cargo or passengers shall be clean and dry, and the certifying officer may, at his discretion, require that it shall be thoroughly disinfected if last from an *infected* port, or if the port of departure be itself *infected*. The examination of the vessel as to cleanliness shall be made before the cargo is taken on, and shall extend to all accessible parts, especial care being taken to note upon the bill of health the presence of decayed wood.

9. Earth and porous stone shall not be used for ballast if avoidable.

10. Merchandise or articles known to be infected shall not be received or taken on board.

11. In case the port is *infected*, the certifying authority may require that the officers, crew, and passengers shall be examined by a medical officer or physician selected for that purpose, and the result of such examination reported to him not more than twenty-four hours before certifying to the bill of health.

12. Bills of health can be considered valid only when delivered within the twenty-four hours last preceding departure. If the departure is delayed beyond this period the bill must be *viséd* by the authority delivering it, stating whatever changes have taken place in the sanitary condition of the port, vessel, officers, crew, or passengers.

13. When the port of departure or its vicinity is *infected*, that fact shall be noted in the bill of health, and when the sanitary or other local authority of the port declares the existence of such infection, the bill of health shall give the date of the declaration.

14. The existence of contagious or infectious disease in the quarantine establishment of a port shall not be considered cause for a foul bill of health.

15. Physicians attached to sea-going vessels shall be specially charged with the duty of watching their sanitary condition and the health of their officers, crew, and passengers. On arrival of the vessel they shall report to the health officer of the port the sanitary history of the voyage.

16. In case of the occurrence at sea of Asiatic cholera, yellow fever, plague, small-pox, relapsing fever, or typhus fever, the wearing apparel and bedding used by those affected with such disease shall be boiled for not less than two hours or burnt or sunk.

17. Captains, owners, or agents of vessels shall, at the port of departure, be required to answer, under oath, to the consuls or sanitary officers all questions as to the sanitary condition of the vessel, &c.

18. Whenever any vessel shall leave an *infected* foreign port, or having on board goods or passengers coming from any place or district infected with Asiatic cholera, yellow fever, or plague, shall leave any foreign port, bound for any port in the United States, the consul, consular officer, or other representative of the United States, at or near such port, may, at his discretion, immediately give information thereof by telegraph to the National Board of Health at Washington, D. C., reporting the name, date of departure, and port of destination of such vessel. The cost of such telegrams will be paid by the National Board of Health.

19. All merchant ships or vessels from any foreign port, where any contagious or infectious disease exists, and bound for any port of the United States, must present to the health officer at the quarantine station of such port evidence that these rules and regulations have been complied with in order that such vessel may enter such port, discharge its cargo, and land its passengers.

[Form A.]

No. ——. Port of ——.

THE UNITED STATES OF AMERICA.—NATIONAL BOARD OF HEALTH.

BILL OF HEALTH.

I, —— —— (consul, consular agent, or other officer empowered by law to sign), at the port of ——, do hereby state that the vessel hereinafter named clears from this port under the following circumstances:

Name of vessel: ——.
Tonnage: ——.
Apartments for passengers, No. ——.
Destination: —— ——.
Name of medical officer (if any): —— ——.
Total number of passengers: First cabin, ——; second cabin, ——; steerage, ——.
Nature (vessel-of-war, ship, schooner, &c.): ——.
Guns: ——.
Where last from: ——.
Name of captain: ——.
Total number of crew: ——.
Cargo: ——.
Sanitary history of the vessel:

....

1. Sanitary condition of vessel (before and after reception of cargo, with note of any decayed wood). Note disinfection of vessel:

....

2. Sanitary condition of cargo:

....

3. Sanitary condition of crew:

....

4. Sanitary condition of passengers:

....

5. Sanitary condition of clothing, food, water, air-space, and ventilation (to be in quantity as required by Rev. Stats.):

....

6. Sanitary condition of port and adjacent country—
a. Prevailing diseases (if any):

....

b. Number of cases of and deaths from yellow fever, Asiatic cholera, plague, small-pox, or typhus fever during the week preceding:

b. Number of cases of—	*b.* Number of deaths from—
Yellow fever, ———.	Yellow fever, ———.
Asiatic cholera, ———.	Asiatic cholera, ———.
Plague, ———.	Plague, ———.
Small-pox, ———.	Small-pox, ———.
Typhus fever, ———.	Typhus fever, ———.
Relapsing fever, ———.	Relapsing fever, ———.

7. Any circumstances affecting the public health existing in the port of departure to be here stated:

....

CLEAN.

I certify that I have personally inspected the said vessel, and that the above statements are correct; that good health is enjoyed in this port and the adjacent country, without any suspicion of yellow fever, Asiatic cholera, or plague; that neither small-pox nor typhus fever exists as an epidemic; that the sanitary condition of the vessel, cargo, crew, and passengers is good; that the rules and regulations prescribed by the National Board of Health have been complied with, and that the [name of vessel] leaves this port in *free pratique*, found for ———, U. S. of A.

[Signature of medical officer.]

Or,

FOUL.

I certify that I have personally inspected the said vessel, and that the above statements are correct, and that she leaves this port bound for ———, U. S. of A., in *quarantine*.

[Signature of medical officer.]

I certify that the foregoing statements are made by ——— ———, M. D., who has personally inspected said vessel; that I am satisfied that the said statements are correct; and I do further certify that the said vessel leaves this port bound for ———, in the United States, in ——— *pratique* [or in quarantine].

In witness whereof, I have hereunto set my hand, and the seal of office, at the port of ———, this —— day of ———, 18—, — o'clock.

[SEAL.] ——— ———,

[*Consul General, Consul, Commercial Agent, Sanitary Officer et al.*]

The within rules and regulations are true copies made this 17th day of June, 1880

J. L. CABELL,
President National Board of Health.

THOS. J. TURNER,
Secretary of National Board of Health.

The foregoing regulations are approved.

R. B. HAYES.

JUNE 17, 1880.

CIRCULAR No. 7.

The following rules govern the action of the National Board of Health in co-operating with and aiding State and local boards to enforce the rules and regulations of such boards to prevent the introduction of contagious and infectious diseases into the United States, or into one State from another:

1. The regulations to be enforced are those of State and local boards, and must be such as are approved by the National Board. The National Board, in its circular published in its Bulletin No. 48, May 29, 1880, has recommended certain regulations with regard to maritime quarantine for adoption by State and local boards; and in its Bulletin No. 50, June 12, in 1880, pages 402–403, it has advised the adoption of certain regulations during the existence of yellow fever.

It should be observed that these recommendations embody general principles only, the end in view being to protect and promote the public health by measures which interfere with travel or traffic as little as possible; in other words, to render commerce

secure; and (with rare exceptions) *not to put an end to or even suspend it.* In this connection it is proper to add that non-intercourse quarantines, especially by *local* authorities, are not approved by this Board.

2. Applications to the National Board of Health for aid should be made by or through the State board; or in case there is no State board, then by or through the governor of the State, and should be accompanied by a copy of the rules and regulations for enforcing which aid is desired.

3. An application for aid must give *details* of what is required, and the estimated cost for each item, and must be accompanied by an official certificate from the governor of the State or the mayor or other chief officer of the municipality, respectively, to the effect that there are no State or municipal funds available to carry out the particular sanitary measures to secure which the application is made.

4. The aid furnished by this Board to local authorities must, as a general rule, be applied to other objects than those of shelter and furniture, which should be furnished by such authorities. Where, however, it shall be otherwise ordered, the local authorities will be expected to account to this Board from time to time for the safe-keeping and proper use of the furniture, provisions, medicines, &c., so furnished.

5. Whenever this board shall order the erection of temporary buildings, or provide any buildings for the purpose of quarantine, the necessary contracts therefor shall be subject to the approval of the Board or of its executive committee.

6. Care should be taken that the officers to be paid from funds furnished by the National Board are employed only in such number and for such time as there is actual need of their services. The National Board of Health reserves the right of judging from time to time, by means of reports received from its own agents, whether such need exists.

7. Funds are not furnished by the Treasury to State or local boards. They are placed in the hands of the disbursing agent of the National Board of Health, by whom bills, properly certified and approved, will be paid by check on Washington or New York. All bills must be in accordance with the estimates as approved by the Secretary of the Treasury, must be made out in duplicate on forms furnished by the National Board, and be certified, as to their correctness, by some authorized officer of the State or local board, and must be approved by some member or inspector of the National Board, duly authorized.

All bills for services rendered, or for articles furnished local or State boards, must be sworn to by the person rendering the service or furnishing the articles.

The names of all persons whose services as inspectors, &c., are to be paid for out of its funds must be submitted to and approved by the National Board.

8. State and municipal boards of health which receive aid from this board are requested to furnish weekly reports to this office of their operations, including copies of orders issued by them and of reports made to them by their quarantine and sanitary inspectors with reference to the occurrence of cases of yellow fever and to measures adopted for isolating such cases; such reports to be presented in a form suitable for publication in the Bulletin.

It is expected that at the close of the season a full report will be made by boards of health to the National Board as to their operations in carrying out those rules and regulations in which the National Board has rendered aid and co-operation, and it is desired that copies of all orders issued from time to time to inspectors shall be promptly furnished to this Board.

It is to be remembered that a full account of its expenditures must be made by the National Board of Health to Congress, and such account must set forth these expenditures in detail, and exhibit their propriety and necessity.

It is therefore essential that State and municipal boards co-operate with the National Board in supplying material for such an account, and it is earnestly desired that they preserve and furnish due evidence of the propriety of each item of their expenditure for both persons employed and articles purchased with the funds in question.

APPENDIX A3.

REPORT FOR THE QUARTER ENDING SEPTEMBER 30, 1880.

STATEMENT OF THE EXPENDITURES AND OPERATIONS OF THE NATIONAL BOARD OF HEALTH FOR THE QUARTER ENDING SEPTEMBER 30, 1880.

NATIONAL BOARD OF HEALTH,
Washington, D. C., October 18, 1880.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

SIR: In accordance with section 8 of the act approved June 2, 1879, entitled "An act to prevent the introduction of contagious and infectious diseases into the United States," the following statement of the operations and expenditures of the National Board of Health for the quarter ending September 30 is respectfully submitted for transmission to Congress. The preparation of this statement has been postponed for a few days beyond the usual period, in order to include the latest intelligence respecting an outbreak of a suspicious disease in the vicinity of the Mississippi quarantine below New Orleans, in regard to the nature of which there was much difference of opinion, but which there is now every reason to believe was a mild epidemic of yellow fever, as will be more particularly stated in another part of this report.

SPECIAL INVESTIGATIONS AND SANITARY SURVEYS.

1. Since the date of the last quarterly report of this Board the sanitary survey of selected portions of Baltimore City, which had been undertaken in compliance with the request of the city council, as set forth in a correspondence between the mayor and the president of this Board, a copy of which accompanied the quarterly report for this quarter ending March 31, has been completed, and the report of Dr. C. W. Chancellor, who had been appointed to conduct the work, has been forwarded to the mayor for transmission to the council. By reference to that correspondence, it will be seen that in consenting to institute this survey the Board expressly disclaimed authority to apply the funds at its disposal to purposes of local sanitation. Accordingly the survey was ordered "not with the view of relieving that municipality of any part of the expense of needful sanitation, but in order to demonstrate to its authorities, by means of the results of such a partial survey, the urgent necessity for prompt action on the part of the council looking to the completion of a similar survey for the entire city, and to enforce the recommendation heretofore made by this Board for a complete system of sewerage" on some uniform plan to be selected after a topographical survey of the city shall have been made by competent engineers. It is the opinion of this Board that the method at present in use for the disposal of the excremental filth in that city is fraught with great danger

to the future health of the community, and, in the event of the int duction of infectious disease, may imperil all the surrounding count

2. The investigation by Prof. Raphael Pumpelly, of the United Sta Geological Survey, on the influence of various soils upon sanitati especially with regard to drainage and the methods of disposal of creta, promises to yield results of much scientific interest and gre practical value. At the request of Professor Pumpelly, Prof. Geor A. Smyth has been associated with him in conducting this investigatio which involves a continuous series of very elaborate and difficult expe ments.

3. The final report by Col. G. E. Waring of his investigation of tl flow of sewers in relation to their sizes and gradients, has been receive and has been published in the Bulletin of the National Board of Healtl vol. 2, No. 6, a copy of which, marked F, will be found in its prope place in the Appendix.

4. The final report of Dr. S. E. Chaillé of his work in connection wit the Havana Yellow Fever Commission, an outline of which was give in his preliminary report heretofore transmitted to Congress, has no been received. It covers 500 pages of foolscap, and will occupy fron 350 to 400 printed octavo pages. Three valuable maps accompany th report, viz, A, map of the so-called "yellow fever zone"; B, map o Cuba; C, map of "Havana and its harbor," and therewith of "Havana its harbor, and suburbs."

It is believed that the publication of this report will prove one of the most valuable contributions ever made on yellow fever, and will undoubtedly be exceedingly useful as a book of reference on the subject of that disease as it exists in Cuba. It is therefore hoped that Congress will, at the approaching session, promptly provide for its publication.

5. Dr. G. M. Sternberg, of the United States Army, who was associated with Dr. Chaillé and others on the Havana Yellow Fever Commission, and who some time after the return of the commission from Havana was directed to continue his researches upon suspended particles in the air of places liable to infection, has recently been engaged in that work in the city of New Orleans, and in the somewhat kindred work of investigating organized particles from the swamps and well-known malarial regions in the vicinity of that city, with the view of verifying or else disproving the observations which have been made by Klebs and Tomassi on the existence of spores in such localities, supposed to have a causal relation to malarial fevers. He is at the present time performing physiological experiments on living animals, with reference to the determination of this question.

6. The investigation by Dr. Charles Smart, U. S. A., into the adulterations of food has been so far advanced as to furnish satisfactory proof that such adulterations are sometimes practiced, and to make it important to extend inquiries in this direction. The investigation will accordingly be carried on during the remainder of the year at least.

NOMENCLATURE OF DISEASES.

At the conference held in Washington on the 6th and 7th of May, in accordance with a request of the National Board of Health as explained in the last quarterly report, the following resolutions offered by a member of this Board were unanimously adopted:

"*Resolved*, That the nomenclature published by the Royal College of Physicians of London be provisionally adopted.

"*Resolved*, That a committee of five be appointed by the chair, whose

duty it shall be to indicate the most urgently needed additions to said nomenclature at the present time, and that this committee shall be instructed to confer with the committee of the Royal College of Physicians in charge of the revision of said nomenclature with reference to obtaining a uniform system both for Great Britain and her colonies and for this country."

Recognizing the great importance of this subject in connection with its bearing on the means of securing an exact registration of the causes of death, this Board has appropriated the sum of $500, or so much thereof as may be necessary, to defray the expenses of a selected member of the committee appointed under the above-cited resolutions, who shall be required to proceed to London and confer with the committee of the Royal College of Physicians engaged in the revision of the standard nomenclature of diseases.

The report of the committee on the best methods of tabulating mortality statistics is now ready and will be promptly published in the Bulletin of the National Board. There is good reason to believe that the tables prepared and recommended by the committee will be promptly adopted by most if not all of the registrars of vital statistics in the United States.

QUARANTINE.

The act approved June 2, 1879, the scope of which is foreshadowed by its title, "To prevent the introduction of contagious and infectious diseases into the United States," and the various requirements of which are in precise conformity with the import of that title, having imposed upon the National Board of Health certain obligations looking to the protection of the public health in that direction, it became a matter of anxious inquiry with the Board how it could best and most efficiently perform the duties prescribed in the law. The decision of this question with reference to a general plan of operations for future seasons was, however, of necessity left in abeyance for a time, by reason of the fact that almost immediately after the promulgation of the law the Board found itself confronted by an alarming outbreak of yellow fever in Memphis and by the occurrence of a few threatening cases in New Orleans. Subsequently the disease appeared in various other localities, as detailed in the first annual report of this Board, which, with its appended documents, has heretofore been transmitted to Congress. The infection having been already introduced, to assist the authorities of the stricken communities in their efforts to stamp out the disease, as a necessary means of preventing its spread to other States, was recognized by the very highest legal authorities of the general government to be the obvious duty of the Board under the provisions of the law which defined its powers. Owing, it is confidently believed, to measures recommended by this Board and to the pecuniary aid extended to the authorities of the endangered communities to enable them to carry these recommendations into effect, the spread of the disease was actually restrained within very narrow limits.

This very desirable result having been accomplished, and the period of danger of further developments of infection being past by reason of the occurrence of early frosts, the inquiry again pressed itself upon the attention of the Board as to its duties with reference to the future prevention of the introduction of contagious and infectious diseases into the United States from foreign countries and from one State into another. In this connection the Board did not overlook the great importance of maintaining, in the localities most exposed to the danger of the impor-

tation of infectious diseases, such an habitual condition of local san tion as would be likely to render the poison when introduced *ab ext* if not wholly inoperative yet much less potent for evil. To this end elaborate sanitary survey of the city of Memphis was made by order this Board, and certain measures, especially with reference to sewera and repaving of the streets, were recommended. These measures w promptly carried into effect by the authorities of that city, and we m well congratulate the citizens of that stricken and impoverished co munity upon the results of their manful determination to bear the e penses incident to the execution of the improvements recommende Notwithstanding the unexampled mildness of the past winter, whi excited the fears of many persons lest some of the germs of the disea which prevailed until late in the fall might retain their activity throug the winter and cause a new outbreak this year, there has not been shadow of suspicion of the occurrence of a single case of yellow fev during the year, and the general health of the city has been unusuall good.

With a similar end in view the Board sent two of its sanitary inspec ors over to the Têche country in Louisiana, which had suffered more o less seriously from the invasion of yellow fever during the previou season, in order to ascertain its actual sanitary condition and what ha been done by the local authorities in the way of local sanitation as measure of prevention against the recurrence of an outbreak. It is no unreasonable to ascribe the immunity which that country has enjoye the past summer from serious invasions of disease, in part at least, to greater care in regard to sanitary improvements consequent upon the action of the Board.

But, whatever care be taken in regard to municipal cleanliness, it is beyond all reasonable question that infected vessels and their cargoes and infected articles transported by railroads may plant the germs of disease in even the most cleanly cities. Accordingly, the municipalities which resolutely determined to exclude the infection at whatever cost and inconvenience to their own citizens and to those who desired to hold commercial intercourse with them, are accustomed in times of great danger to maintain the policy of absolute non-intercourse, enforcing this policy when necessary by means of the so-called "shot-gun quarantine," the barbarous cruelty of which has been made familiar to the public by numerous well-authenticated incidents of the epidemic of 1878. The efficiency of this policy was, however, abundantly established by the immunity enjoyed by numerous towns in the Valley of the Mississippi which adopted it, while the infection prevailed everywhere around them. To remove all occasion for the use of such a measure, by securing an adequate protection of the public health with the least obstruction to trade and travel, was doubtless the motive which led to the passage of the act of June 2, which had for its end the prevention of the introduction of contagious and infectious diseases into the United States from foreign countries or from one State into another, and which accordingly made it the duty of the National Board of Health to co-operate with and assist State and municipal boards of health in their efforts to secure these ends by means of quarantine regulations. With reference to

MARITIME QUARANTINE

as a means of preventing the introduction of disease into the United States from foreign countries or from an infected port of one State into those of another State by sea, there were two conceivable ways in which

this Board might attempt to render aid to the local authorities. One was to make a *pro-rata* distribution of the funds at its disposal and available for this purpose to all the ports of entry which might seem to need such aid. This was at once rejected for the reason that, in addition to other more or less potential considerations, such, for example, as its opposition to the general tenor and spirit of the law and to the rulings of the Treasury Department, the distributive share of each beneficiary would have been so small as to render the act practically nugatory, inasmuch as a complete quarantine establishment is somewhat expensive with the original construction and as respects the annual cost of maintenance, including as it does a hospital for the sick, a lazaretto for persons not sick to be kept under observation until their freedom from infection is clearly established, a warehouse for the temporary storage of the cargoes of infected vessels, wharves to facilitate landing, lighters for conveying disinfected cargoes to the wharves of the port of destination, the sea-going vessels being sent to sea and thus returned to the uses of commerce in the shortest practicable time, and, finally, accommodations for the quarantine officer. To have given aid to this extent to all the exposed ports which needed it on the South Atlantic and Gulf coasts would have required more than ten times the amount of funds under the control of the Board. The only alternative seemed to be to select a few points so located as that a completely equipped quarantine station at each of them might avail for the protection of the intermediate ports, if their respective authorities would require all infected vessels bound for such ports to proceed first to these fully-equipped stations in order to undergo appropriate treatment. In such a case the ports themselves would need only the services of an inspecting officer to board vessels and to remand to the nearest national quarantine station such as had improperly attempted to enter the port against the published directions distributed by pilots.

As the stations thus proposed to be established were for the benefit not of a single State but of several, it was considered to be necessary and every way desirable to work them through the agency of employés directly responsible to the Board. The authority to do this was believed to be conferred by the law of June 2, 1879, inasmuch as it would be in aid of State and municipal boards of health, and this aid was to be extended at their request and with their active co-operation. The Board did not, however, take a step in this direction until it was fortified by the opinions of the legal advisers, namely, Solicitor-General Phillips, representing on this Board the law department of the Government; Judge Porter, First Comptroller of the Treasury, who, under the law, had to pass upon all its accounts; and of Senator Harris, chairman of the Committee on Epidemic Diseases, which had framed the act in question. In the opinion of the latter eminent jurist the Board would have been derelict of its duty if it had failed to inaugurate some such measure for the protection of the country from the introduction of infectious diseases from abroad.

In undertaking this work the Board had the advantage of the remarkably successful experience of the quarantine authorities of the State of New York in protecting not only the ports of that State but all those of New Jersey and Connecticut which are reached through the harbor of New York. In the earlier operations of that quarantine only the vessels bound for the city of New York were subjected to its regulations, and though they proved effectual to exclude the *direct* importation of infectious diseases, it was soon found that such diseases, having been carried up the Sound, gained admission into the city by land from

ports and places in Connecticut. This led eventually to the subject to the regulations of the New York quarantine all vessels entering harbor, whatever might be their ultimate destination. This, it is lieved, has been done without special legislation, but with the rea and cheerful acquiescence of the authorities of New Jersey and Conn ticut. In like manner the quarantine station in Boston Harbor m avail, and to some extent it is believed has availed, for the benefit other ports on the New England coast. On the South Atlantic a Gulf coasts, where, owing to climatic peculiarities and proximity to t permanently infected ports of Cuba, quarantine treatment of vessels specially necessary for the public safety, there are no wealthy munic palities able to protect themselves and their neighbors. Periodical they are inflicted with disastrous epidemics which entail commerci losses and untold misery not only on the population of the ports fir infected from abroad, but over a wide extent of the surrounding cou try. In the opinion of this Board this gigantic evil may be averte to a very large extent by the establishment, at a comparatively mode ate expense, of a few completely-equipped quarantine stations, whic may give to the ports of the South Atlantic and Gulf coasts the sam protection which the New York quarantine has secured for that Stat and for the ports of Connecticut and New Jersey. This Board ventures, at the hazard of incurring the charge of tedious repetition, to bring this subject again to the attention of the honorable Secretary of the Treasury for transmission to Congress, in view of the fact that the Committee on Appropriations, to whom it was presented during the last hours of the recent session of that body, were not fully informed of the force of the considerations which actuated this Board in taking measures for the establishment and maintenance of the quarantine stations in question.

In the quarterly report of this Board for the quarter ending June 30, after adverting to the importance of the establishment and maintenance of quarantine stations under the auspices and control of the Board at Hampton Roads, Sapelo Sound, and Ship Island, it was stated to be "a subject of regret that owing to recent legislation by Congress it has not been possible to carry out these views except in a very partial manner.

"The funds at the disposal of the Board have necessitated, in the case of Hampton Roads, a temporary abandonment of a national quarantine, substituting therefor aid to the local authorities by the loan of a barge, purchased and equipped as a floating hospital, at a cost not to exceed $6,000. This was found to be less expensive, and in all other respects much better than to repair and fit the hulk of the Savannah, lying at the navy-yard at Portsmouth, Va., which had been courteously granted for the use of the Board by the Secretary of the Navy. For a like reason a temporary arrangement has been made at the Sapelo Sound station by the use of hospital tents on the southern end of Blackbeard Island, and by the purchase of a steam-launch for boarding vessels. The erection of a hospital, lazaretto, warehouse, and wharf at Ship Island had already proceeded so far before any question as to the policy arose as to make it highly inexpedient to alter the original plans of the Board in respect of that very important station."

It is earnestly hoped that Congress will make adequate provision for the maintenance of this station, for the substitution of an adequate equipment at Hampton Roads and Sapelo Sound, in lieu of the temporary make-shifts adopted this summer, and for the establishment in Galveston Bay, or elsewhere on the coast of Texas, of a station for the

protection of its extended coast line between Galveston and the mouth of the Rio Grande.

The municipalities most immediately concerned recognize the great value of these national quarantines, and earnestly desire that the machinery which will secure them against the introduction of infection from abroad, and thus against the risk of becoming the means of transmitting infection to other parts of the United States, shall be perfected and perpetuated. There is a partial exception to this remark in the case of New Orleans, where, although all the leading representatives of its commercial interests are known to be extremely desirous that infected vessels shall be required to proceed to the national quarantine at Ship Island instead of coming up the river to the Mississippi quarantine, to the great jeopardy of the population of the surrounding country on both sides of the river, the wishes of the community have been thwarted by the action of the State board of health, which has hitherto repelled all offers of aid on the part of the National Board looking to the reception and treatment at Ship Island of infected vessels bound for the port of New Orleans. This action of the State board of health of Louisiana has caused great dissatisfaction and alarm on the part of the people of the Mississippi Valley, who believe that there can be no adequate guarantee of the protection of the public health throughout the valley as long as infected vessels are permitted to enter the Mississippi River. This belief, and the consequent distrust of New Orleans entertained by the health authorities of the States bordering on the river and its tributaries, are expressed in firm but temperate language in numerous articles of the daily press and in official ordinances of State and municipal boards of health. Attention is specially invited to "An open letter to his excellency, the chief executive of the State of Louisiana," addressed to that officer August 14, 1880, by G. B. Thornton, M. D., and John Johnson, members of the State board of health of Tennessee. Copies of these several papers, marked B, are hereto annexed.

The immediate occasion for the course adopted by the authorities of Tennessee and Mississippi, as alluded to in these papers, was the arrival of the bark Excelsior at New Orleans after a detention of eleven days at the Mississippi quarantine, and the occurrence of a fatal case of yellow fever among the crew during the discharge of its cargo of coffee. As soon as it was clearly established that the case in question was one of yellow fever the vessel was ordered back to quarantine, where four other cases occurred on board said vessel, of which two were fatal.

While the State board of health of Louisiana has thus, in defiance of the demands of the health authorities of the neighboring States, whose interests are so vitally concerned, declined to accept the offer of the National Board to receive and disinfect vessels clearing for New Orleans from infected ports, the authorities of all the ports between that city and Cedar Keys have signified their purpose to direct all infected vessels to report to the national quarantine at Ship Island before proceeding to their ports of destination.

In like manner the health authorities of the ports of the South Atlantic coast have solicited the establishment of a national quarantine in Sapelo Sound, and have instructed pilots to make inquiry, in all cases before boarding, as to the sanitary condition of the vessels destined for these ports, and to order "all vessels having sickness on board, or on which serious cases have occurred during the voyage, to proceed at once to the national quarantine at Sapelo."

The period of danger with reference to the introduction of yellow fever into the United States, for the present season, being well-nigh past,

measures have been taken to discontinue operations at Sapelo Sou and to reduce the force at Ship Island by relieving the present quar tine officer, Dr. Martin, who will be placed on the reserve list, and directing Dr. Collins, late supervising sanitary inspector at New Orlea to take charge of the public property on the island and to perform t duty of boarding and inspecting all vessels which may require it duri his stay at that station. These measures have been taken in conformi with the suggestions and advice of Dr. Bemiss, a member of this Boar who has had the general supervision of its work in New Orleans and t surrounding country, and especially of the operations at the Ship Islan quarantine. It should be borne in mind that yellow fever prevails i Havana during every month of the year, and that in mild winters th ports of the gulf coasts would probably not be exempt from the risk a general infection if infected vessels were permitted to come to thei wharves.

As connected with this arrangement for the winter, it may be state that the aid heretofore extended to the health authorities of the town on the gulf coast, between New Orleans and Pascagoula, has been sus pended by placing on the reserve list the several sanitary inspector at the ports of Hancock and Harrison Counties, on the Mississippi Sound.

INTERSTATE QUARANTINE.

In conformity with the views and purposes expressed in former reports of this Board, especially in the last quarterly report, the systematic inspection by paid agents of the Board at New Orleans, Vicksburg, Memphis, and Cairo, of vessels bound for various points on the Mississippi above New Orleans, and at Bayou Sara of vessels proceeding up the Red River, has been in successful operation during the summer under the constant supervision and direction of Dr. R. W. Mitchell, of Memphis, a member of this Board, and has been productive of the best results in giving confidence to other communities otherwise disposed to establish a rigid quarantine against the city of New Orleans on the bare suspicion of the existence of a single case of yellow fever in that city.

Exception was taken by the State board of health of Louisiana to an order alleged to have been given by an agent of the National Board, prohibiting the shipment to Mobile and to ports and places in the State of Mississippi of coffee from the infected bark Excelsior, on which, as just recited, several cases of yellow fever had originated shortly after the handling of its cargo at the city wharves. In point of fact the order in question emanated from the health authorities of Mobile and Mississippi, and was promulgated by their authority by Dr. Rice, an agent of the National Board, with the simple view of warning shippers that the article, if shipped, would be declared contraband of quarantine, and would not be permitted to enter the ports referred to. The State board of health of Louisiana had previously been informed by an official communication (copy hereto attached, marked C) from the president of this Board that the latter disclaimed any authority to interfere with the shipment of goods, or even to make inspections of steamboat freights, except at the request of the owners or captains of the boats, and the State board had, through its president, united in an earnest application to the National Board to make these inspections, not only of river craft, but also of railroads leading out of the city, on the ground that both were essential to give confidence to other communities. It is, indeed, true that the value to New Orleans of these inspections, in securing it

from needless restrictions on its commerce, which otherwise would have been imposed by neighboring States, can scarcely be exaggerated.

An order to suspend these inspections by the 15th September for railroads, and by the end of the month for river craft, had been issued, when an earnest request was made by the authorities of Vicksburg, Miss., to reconsider the order so far as the river inspection service at that station was concerned. In compliance with this request the period was extended to the 15th October. The request was based upon an apprehension that an alarming outbreak of serious disease near Point á la Hache, in the vicinity of the Mississippi quarantine, might prove to be an epidemic of yellow fever, which had originated in the cases occurring on the infected bark Excelsior. Such, indeed, was the deliberate opinion of several competent physicians, and especially of Dr. G. M. Sternberg, of the United States Army, who has had a large experience in yellow fever epidemics, and has made a special study of the character of the disease both in the United States and in Havana, as a member of the yellow fever commission appointed by this Board to proceed to the latter place in order to investigate the nature of the fever in a locality where it has become permanently endemic. When this opinion was made known, a communication was addressed to the State board of health of Louisiana by Dr. S. M. Bemiss, the local representative of the National Board in New Orleans, offering pecuniary aid to prevent the spreading of the disease. This offer was declined on the ground that there was no yellow fever in or near the city; whereupon, at the request of the citizens of New Orleans, a further investigation was made by a commission consisting of Dr. J. P. Davidson, of the State board, Dr. Sternberg, U. S. A., and Dr. J. D. Bruns, of New Orleans. A majority of this commission came to the conclusion that the disease in question was not yellow fever, but a severe form of malarial fever, probably caused by miasma from rice fields in the vicinity. From this opinion Dr. Sternberg has expressed dissent, reiterating the emphatic expression of his belief that the disease, which is mainly confined to young persons, is a mild form of yellow fever; and in this opinion Drs. Bemiss and Mitchell, members of this Board, who have had a large experience in connection with yellow-fever epidemics in New Orleans and Memphis, have officially expressed their concurrence. Their reports and other papers relating to this question have been published in the Bulletin, No. 16, a copy of which is hereto appended, marked D. It should be added that shortly after the reception of these reports the existence of an undoubted case of yellow fever within the limits of the city was announced in an official telegraphic dispatch to this office, signed by Dr. Bemiss and by Dr. Loeber, acting president of the State board; and Dr. Bemiss, in an official communication dated October 6, states that other cases, probably as undoubted as this, have occurred in and near the city.

AID TO THE DISTRICT OF COLUMBIA.

Information having been received at this office from Havana, Cuba, of the sailing from that port on the 24th August of an infected vessel, the Emma J. Lewis, bound for Washington, the same was promptly communicated to the health officer of the District, Dr. Smith Townshend, and on his application for aid to prevent the introduction of yellow fever into the District of Columbia a requisition was made for the sum of $250 to enable him to employ a sanitary inspector with authority to stop at the District limits all suspected vessels.

It should be added that the vessel in question has not arrived wit the jurisdiction of the District, nor is it known that she has appea within the capes of Virginia.

A statement of the expenditures of the Board for the quarter is he with respectfully submitted.

J. L. CABELL,
President National Board of Health.
T. J. TURNER,
Secretary National Board of Health.

Statement of the expenditures of the National Board of Health for quarter ending Septemb 30, 1880.

On what account.	Month of July, 1880.	Month of August, 1880.	Month of September, 1880.	Total for quarter ending September 30, 1880.
Floating quarantine on Mississippi River	$4,001 05	$3,676 94	$2,310 40	$9,988 3
Ship Island quarantine	5,222 57	1,285 08	5,229 63	11,737 2
Blackbeard Island quarantine	2 12	332 56	2,432 74	2,767 4
Elizabeth River quarantine	....	1,762 50	555 25	2,317 7
Aid to Pensacola, Fla	2,075 06	545 67	574 90	3,195 63
Aid to Pascagoula, Miss	....	....	97 58	97 58
Aid to Hancock County, Mississippi	....	....	319 85	319 85
Aid to Harrison County, Mississippi	....	28 50	325 20	353 70
Aid to State board of health, Louisiana	....	665 00	825 00	1,490 00
Aid to State board of health, Texas	....	....	125 00	125 00
Aid to Charleston, S. C	....	40 20	....	40 20
Havana commission	....	662 30	....	662 30
Pay and expenses inspectors at Havana, Memphis, &c.	1,861 00	1,530 05	1,678 10	5,069 15
Special scientific investigations	82 30	144 40	623 03	849 73
Pay and expenses members of the Board	634 05	1,102 36	822 79	2,559 20
Storage of tents, &c	103 50	157 25	....	260 75
Printing of the Bulletin of the National Board of Health	1,103 03	596 86	448 00	2,147 89
Printing of blanks, &c	9 52	46 74	116 39	172 65
Pay of clerks, messengers, &c	1,508 08	1,483 83	1,458 53	4,450 39
Rent, light, and fuel	105 40	....	107 00	212 40
Telegrams	12 28	48 09	35 74	96 11
Furniture, stationery, &c	748 30	17 50	....	765 80
Miscellaneous expenses National Board of Health	52 68	130 77	59 41	242 86
Total for the quarter ending September 30, 1880	17,520 89	14,256 60	18,144 04	49,921 53
From the date of organization of the Board to June 30, 1879, there was expended				9,146 41
From June 30, 1879, to June 30, 1880, there was expended				266,762 16
Total amount expended by the Board from date of organization				325,830 10
Total amount expended at Ship Island quarantine, including purchase of boats, construction of wharves and buildings, and maintenance of same, has been				30,726 17
Total amount expended for purchase of boats, establishing stations, and maintenance of the Mississippi River inspection service				50,526 50

B.*

QUARANTINE IN NEW ORLEANS.

An open letter to his excellency the chief executive of the State of Louisiana.

MEMPHIS, TENN., *August* 14, 1880.

SIR: In view of recent public and official strictures upon the Tennessee State board of health, on account of its order issued July 14, concerning the sanitary supervision of intercourse with New Orleans during the existence of a threatened danger to the public health of the Mississippi Valley, it seems fitting that the representatives of the State board resident in this city, and who are largely responsible for that order, should take some cognizance of those criticisms.

*For "A," see Appendix G, *post*.

It ought to be entirely unnecessary to say that nothing but the kindliest feelings do or can exist toward New Orleans from Memphis and the State of Tennessee. We believe our interests, if not identical, are at least so much in common, that whatever helps or hurts New Orleans, helps or hurts Memphis and the rest of the valley. If, however, New Orleans brings harm to herself by neglecting proper precautions (for example, in the admission of vessels from ports infected with yellow fever), then the law of self-preservation demands that the rest of the valley, which has been so often scourged through New Orleans, shall take such steps as may be needed to confine that harm, if possible, to the community which has permitted it through negligence or indifference.

While such steps may be taken reluctantly, and with regret that the necessity for them exists, the authorities charged with the protection of the public health cannot hesitate to do their sworn duty. It was with this conviction that the order in question was issued—an order which, it should be noted in passing, applied mainly to articles described in the printed rules and regulations of the Louisiana State board of health as being dangerous under such circumstances as those attending the Excelsior affair, and which that board declares should be subjected "to obligatory quarantine and purification." (See "Rules and Regulations Louisiana State Board of Health, 1880," page 8.)

That the order of the Tennessee board of health was wise, timely, and beneficent in its workings there is ample evidence, aside from any interested testimony of the board itself. It is not too much to say that its prompt publication arrested a fast-growing tendency to panic and preparation for local "shot-gun" quarantines, begotten of the alarming announcement of an outbreak of yellow fever on a coffee ship in New Orleans, the details of which were recited at a meeting of the Louisiana State board of health, on July 12, and upon the published report of which the Tennessee order was based. Had the order been longer delayed, or not issued at all, past experience forces the conviction that travel would have been impeded and traffic more or less completely interrupted.

That the requirements were not made more stringent, and did not impose greater restrictions upon commercial and personal intercourse between New Orleans and the State of Tennessee is due solely to the confidence reposed in the inspection service of the National Board of Health, both at New Orleans and throughout the valley. In the absence of this agency it would have been the imperative duty of the State board, and of local boards throughout the State, to recommend the absolute prohibition of all freight, and a quarantine of observation for all compromised passengers, from New Orleans, until a sufficient period had elapsed to determine whether the five cases and three deaths from yellow fever among the crew of the Excelsior, and her 3,600 sacks of presumably infected coffee, were to be the seeds of another epidemic, as the single case from the Valparaiso was the seed of the epidemic of 1873, with its harvest of 16,000 cases and 4,000 deaths in Shreveport, and Memphis, and Montgomery, Ala., and Calvert, Tex., and other places; or as the single case from the Emily B. Souder was the insignificant and uncared-for beginning of the wide-spread pestilence of 1878.

It is submitted to your excellency, and to the public, that the inconvenience and pecuniary losses caused by this admission of a vessel from an infected port into the port of New Orleans in midsummer, bear no comparison to the cost (aside from the question of human life) which similar action has entailed in the past.

How far the State board of health of Louisiana is to be credited with the good fortune that an epidemic has not yet resulted from the Excelsior it is not our province to discuss. But it is entirely proper to assert, in the light of what has since occurred, that the orders of the State boards of health of Mississippi and Tennessee averted a panic, prevented the interruption of travel and traffic, and restored confidence throughout the valley of the Mississippi in many communities which have not yet forgotten the history of the year 1878.

Very respectfully,

G. B. THORNTON, M. D.,
JOHN JOHNSON,
Members Tennessee State Board of Health.

The following circular has been issued by the State board of health of Tennessee relating to commerce with New Orleans:

OFFICE OF STATE BOARD OF HEALTH,
Nashville, Tenn., July 14, 1880.

Whereas one death from yellow fever, and two other cases, have occurred in New Orleans among the crew of the coffee ship Excelsior, from Rio de Janeiro; and

Whereas the history of said ship, as recited at a meeting of the Louisiana State board of health, held in the city of New Orleans on the 12th instant, conclusively

shows that the vessel and her cargo are infected with yellow fever; that her infect cargo is now stored in a warehouse in that city; and that her captain, some membe of her crew, and a large number of visitors, as well as the persons (seventy-five or mor who were engaged in and about said infected vessel in breaking out cargo, and i handling, draying, and storing her infected merchandise, are scattered througho said city; and

Whereas this board is charged with the duty of protecting the public health of th commonwealth against the introduction of contagious and infectious diseases, and be lieves such introduction is now seriously threatened by the above-described conditio of affairs at New Orleans, it is therefore hereby ordered—

First. That on and after the date of this publication no freight car over any railroad nor any steamboat or other water craft departing from the city of New Orleans afte the 15th day of July, 1880, and until further orders, shall be allowed to enter th State of Tennessee, nor to make a landing upon the borders of the State for the pur pose of transacting any business whatsoever, unless said car, boat, or water craft shal present to the proper officers of this board a certificate from an officer or agent of the National Board of Health to the following effect:

(*a*) That said officer or agent of the National Board of Health has personally examined the freight of such car, or the cargo, passengers, officers, and crew of such steamboat or water craft, and has satisfied himself of the freedom from infection of said vehicle and its contents (persons and things).

(*b*) That the freight or cargo comprises none of the following articles of the list recommended by the Louisiana State board of health to be subjected to obligatory quarantine and purification, to wit: Clothing, personal baggage and dunnage, rags, paper stock, hides, skins, feathers, hair, and all other remains of animals; cotton, hemp, woolens, and coffee; nor any of the following additional articles, which are hereby declared contraband of quarantine in this State, to wit: Second-hand bedding, clothing, upholstered furniture, and textile fabrics; moss, jute, and "excelsior"; tropical fruits and productions.

Second. That any of the articles above enumerated may be shipped as freight from New Orleans, and transported through the State of Tennessee by rail, if carried in close box-cars, securely locked, and in charge of an officer or agent of this board. The expenses of such officer or agent shall be defrayed by the railroad transporting such goods.

Third. That this order shall be enforced on the railroads at the southern State line by the officers of the board appointed for such purposes; and at Memphis, and elsewhere upon the Mississippi River, by the wharf-master, or other duly authorized officer. The penalties prescribed by law for the violation or infraction of the orders of this board will be rigidly enforced in carrying out this order.

T. A. ATCHISSON, M. D,,
President.
W. M. CLARK, M. D.,
Secretary.
E. W. COLE,
JOHN JOHNSON,
J. D. PLUNKET, M. D.,
J. M. SAFFORD, M. D.,
E. M. WIGHT, M. D.,
Members.

The following circular, relating to the same subject as the preceding, has been issued by the State board of health of Mississippi.

OFFICE OF MISSISSIPPI STATE BOARD OF HEALTH,
Jackson, Miss., July 16, 1880.

Whereas the bark Excelsior, from Rio de Janeiro, laden with coffee, having arrived at New Orleans infected with yellow fever; and

Whereas her cargo is now stored in a warehouse in the latter city, and it is said a number of persons who were engaged on and about said bark in unloading, draying, and storing her cargo are now in said city, it is therefore hereby ordered—

First. That on and after this date, and until further orders, no car or train of cars departing from the city of New Orleans shall be allowed to enter this State, and no steamboat or other water craft from said city shall be allowed to land at any point in this State unless they have undergone an inspection by an officer of the National Board of Health, as is provided in the rules of said board, and are provided with a certificate of such inspection.

Second. That no part of the cargo of the bark Excelsior, and no freight from the warehouse in which said cargo is stored, shall be brought to any point in this State.

Third. That no persons from New Orleans shall be allowed to come to any point in this State unless they hold a certificate from an officer of the National Board of Health that they have not been exposed to infection.

Fourth. That the chief health officers of the counties and the municipal boards of health are charged with the enforcement of this order, and any violation thereof will be punished as is provided by law.

WIRT JOHNSTON, M. D.,
ROBERT KELLY, M. D.,
Executive Committee.

Approved.
J. M. STONE, *Governor.*

C.

NATIONAL BOARD OF HEALTH,
Washington, D. C., August 10, 1880.

SIR: Your communication of July 30, relative to the action of Dr. C. A. Rice, concerning the shipment of coffee from the port of New Orleans to Mobile, and to ports and places within the State of Mississippi, was duly received. A reply thereto was deferred until a report could be received from Dr. Rice, to whom, on the receipt of your communication, a letter of inquiry was addressed. I now find that Dr. Rice had anticipated the receipt of that letter, and had, on the 5th of this month, addressed a communication to the acting governor of Louisiana, furnishing an explanation of his action in the premises. This Board has also received by yesterday's mail a copy of a letter addressed to you by Dr. Bemiss the 2d of August. These two communications by a member of this Board and by one of its agents are approved by the executive committee, and cover the ground so well as to supersede the necessity for any more elaborate explanation.

It appears so obvious that the orders of Dr. Rice, though expressed in, perhaps, unguarded language, could have no other significance than that which is explained in his communication to the acting governor, that I cannot withhold the expression of my great surprise that after the explanations heretofore given you of the principles which have invariably guided this Board in the management of the inspection service at New Orleans, and your avowed concurrence, you should now seek occasion to ascribe to it or its agents any disposition to assume powers which it has never exercised or claimed to possess, and for the attempted exercise of which it would have incurred a great responsibility.

In this connection I refer to my letter of June 15, and your reply thereto, dated June 25.

In the former, adverting to the fact that certain rules and regulations which have been submitted to the State board of health of Louisiana were not intended to be in aid of that board, but of the health authorities of places above New Orleans, I remarked:

"This Board claims no authority whatever to require the owners of boats to submit to such inspection, but in the interest of inter-State commerce it agrees to make these inspections and to furnish certificates in the case of steamboats, &c., *upon request of the owner, agent, or captain of such boats*, in the hope and belief that the certificates will prevent unnecessary interference above, and thus operate to the great advantage of New Orleans and the towns above. If the authorities of New Orleans choose to make it obligatory on the masters of boats clearing from that port to undergo these inspections, the National Board could have no objection, but it disclaims any authority to make such order itself. The rules in question being recommended for the protection of places above New Orleans will doubtless be enforced by the local authorities of such places. The special object for which they were submitted to the State board of Louisiana was to invite suggestion and criticisms before they were finally adopted by this Board itself, and I may remark that since they were thus submitted they have undergone some modifications. As adopted they will be printed in No. 50 of the Bulletin, a copy of which will be sent to you as soon as it comes out."

I further said:

"The executive committee directs me to say that while it has approved the appointment by Dr. Bemiss of three medical inspectors of railroads *nominated* by you, it does not clearly see that it was necessary or desirable to inaugurate railroad inspections in the absence of yellow fever, and inasmuch as a recent act of Congress in largely reducing the appropriation asked for by this board, and restricting the use of a large part of the appropriation that was granted to the contingency of an epidemic, it will probably not be possible to continue this service beyond the present month (June), unless in the mean time cases of yellow fever should have occurred, in which contingency a portion of the appropriation not now available will become subject to the uses of the Board in extending aid to local and State boards of health."

In your reply, dated June 25, you say:

"The board of health authorized the president to express the conviction that the inspection of railroads is equally important with the river inspection service, and that both *are essential* to give confidence to the surrounding States and towns. The river inspection would be comparatively valueless without the railroad inspection, of which fact the faithful and efficient corps of inspectors have given many proofs. Dr. Rice of the National Board (inspector), is in full accord with the State board on this subject. Up to the present moment the parties interested in the railroads and steamboats have yielded cheerful acquiescence to all the rules and regulations of the inspection service."

I have now to say that in no instance has this Board violated the principles avowed in my letter to you, and that if any of the inspectors at New Orleans whose salaries are paid by this Board, and most of whom were nominated by yourself, have transcended their authority, such act on their part will be disavowed and proper instructions promptly given.

I may observe, however, that even before receiving Dr. Rice's version of the matter the executive committee of this Board were of the opinion that the facts cited in your letter of July 30 did not sustain the interpretation you seemed desirous to put upon them. The committee was well assured that Dr. Rice could not possibly have meant to assert an authority which he had no means of enforcing, and the assertion of which would have been in direct violation of his instructions.

With reference to the last sentence of your letter, in which you complain of the action of Dr. Rice on the ground that it was taken "without the advice or co-operation of the lawful authorities to whom are confided by legislative enactment the conduct of the sanitary and quarantine affairs of the State of Louisiana," I have again to repeat the statement in my letter of June 15, that the whole of this river and railroad inspection service is intended for the protection of other States than your own, and is in aid of their health authorities. Incidentally, indeed, it was designed and has proved to be of great advantage to the commerce of New Orleans, since on the bare suspicion of a single case of yellow fever existing there the health authorities of the Mississippi Valley, and of other places in the South having commercial relations with that city, have declared that they will maintain a strict quarantine against it unless the interstate commerce be carried on in accordance with the rules of the inspection service. These authorities have it in their power to protect their towns by a very simple and effective machinery. This Board has induced them to forego the use of such machinery and to consent to an arrangement which has proved highly advantageous to the commercial interests of New Orleans, and yet it encounters at the hands of the health authorities of Louisiana constant opposition and detraction. It is needless to say that it will continue to discharge its duties in aid of the health authorities of other States and municipalities notwithstanding the present opposition of the State board of health of Louisiana.

I will add that, owing to a delay in completing the arrangements at Ship Island, which has been due to causes beyond the control of the National Board, the time for extending aid to the health authorities of New Orleans with regard to the prevention of the introduction of contagious and infectious diseases through that port into the United States from foreign countries has not yet arrived. A recent official report to this Board by a committee consisting of three of its members satisfies the executive committee that the sanitary interests of New Orleans, and the surrounding country, will be best subserved by requiring infected vessels, and all vessels from infected ports, to undergo quarantine inspection and treatment at the proposed station on Ship Island. In this way aid will be offered to the State board of health of Louisiana for the protection of New Orleans and all places in direct communication with it.

I will further add, as suggested by the general tenor of your communication, that while the acts of Congress require the National Board of Health to co-operate with, and, so far as it lawfully may, aid State and municipal boards of health, it was obviously for the purpose of ascertaining and deciding when and in what manner such aid should be given that a National Board was created. Had this not been so, and had Congress intended to allow each State and each municipality to decide these questions for itself, it would, doubtless, have dispensed with any intermediate instrumentality, and have authorized each local authority to make its requisition directly on the Treasury Department for funds needed to carry out its objects.

Respectfully,

J. L. CABELL,
President National Board of Health.

Dr. JOSEPH JONES,
President of State Board of Health of Louisiana, New Orleans, La.

D.

THE FEVER ON THE LOWER MISSISSIPPI.

NEW ORLEANS, *October* 4, 1880.

SIR: Definite information of the existence of a suspicious form of fever in Plaquemine Parish, La., on the Lower Mississippi, having been received by the member of the National Board of Health resident in New Orleans, George M. Sternberg, surgeon, U. S. A., was requested to visit the locality, examine such number of cases as might be necessary to enable him to determine the nature of the fever, and report the result of his investigation to the New Orleans member. Surgeon Sternberg was selected for this duty because of his extensive and intimate acquaintance with the fevers of the Gulf coast and Spanish Main; because of the recognized skill and ability which had led to his being chosen one of the experts on the Havana Yellow-Fever Commission, and to his being intrusted with the duty of preparing the article on yellow fever in the supplement to Ziemssen's Cyclopedia, and also because of his position as a United States Army medical officer, which, while it removed him on the one hand from the probability of having his judgment or conclusions influenced by local or personal considerations, on the other, devolved upon him the responsibility of representing an extremely sensitive professional body.

On the 10th of September, Dr. Sternberg made a detailed report, in which, after reciting the history of the sickness from the appearance of the first case, early in August, up to the date of his investigation, he positively asserted the existence of yellow fever of a mild type, with a low rate of mortality, except where the disease was aggravated by vicious local conditions. In the area where this prevailed, Dr. Sternberg also found a malarial fever, attributed by the local physicians to exposure in the rice harvest, and which they called rice fever.

Upon receipt of this report a telegram was sent to the executive committee asking that, if Dr. Sternberg's opinion was of sufficient weight, an appropriation of from five thousand to ten thousand dollars be made from the contingent fund and placed at the disposal of the Louisiana State board of health for use in the necessary preventive measures. The appropriation was immediately ordered, and a tender of the sum was made, as above indicated, on the 13th of September.

Recognizing only the existence of the so-called rice fever, the State board declined the offer of the National Board and claimed to have "instituted such measures as it deemed necessary." Up to this time the action of the Louisiana member representing the National Board of Health had been governed by that portion of section 3 of the act of June 2, 1879, which makes it the duty of the Board to "co-operate with and, so far as it lawfully may, aid State and municipal boards of health in the execution and enforcement of the rules and regulations of such boards to prevent the introduction of contagious or infectious diseases into the United States from foreign countries, and into one State from another."

The rejection of this proffer to "co-operate and aid," however, now made it incumbent upon the National Board, through its representative, to take such steps as might determine whether the contingency was grave enough to warrant action under that clause in section 3, which directs the Board to "report the facts to the President of the United States," whose duty it then is to use the executive authority in executing and enforcing the necessary rules and regulations. With this object the member of the National Board of Health resident in Memphis was summoned to New Orleans, and, after careful consideration of all the facts, it was decided to send a commission of three medical gentlemen to the compromised locality, and to base the action of the Board upon the report of said commission. These gentlemen (selected with the approval of the auxiliary sanitary association) were Dr. J. Dickson Bruns, of New Orleans, Dr. J. P. Davidson, of the Louisiana State board of health, and Surgeon Sternberg, U. S. A., and they were accompanied on their mission by the Tennessee member of the National Board, the Louisiana member being prevented by his only partial convalescence from a recent attack of the prevailing dengue.

Without entering upon any discussion of the two reports made, the one by Drs. Bruns and Davidson, and the other by Surgeon Sternberg, it is sufficient for the present purpose to say that it was made evident, as well by the conflicting reports of the commission as by the personal observations of the Tennessee member, that no practical benefit could now be attained from executive interference.

Whatever danger had threatened the public health of the Mississippi Valley had either passed away—the disease having run its course—or it had been so widely scattered that preventive measures on any adequate scale were impracticable for the time being.

Considering the advanced stage of the season, the favorable health conditions of the valley, the more than doubtful utility of any steps still possible looking to isolation,

disinfection, &c., and the desirability of avoiding overt action likely to create anxi and apprehension, if not positive panic—these considerations have induced the re sentatives of the Board to refrain from recommending further action in the prem at the present time.

They cannot, however, close this report without placing themselves on record fully accepting and indorsing Surgeon Sternberg's conclusions, to wit:

1. That yellow fever (about 100 cases) existed between August 1 and September in Plaquemine Parish, Louisiana.

2. That the outbreak had its origin in the immediate vicinity of the Mississi River quarantine station, the first case, August 1, occurring directly opposite the poi where the infected bark Excelsior was detained from July 11 to August 16.

3. That while the type of the disease was generally mild, vicious local conditio existed which aggravated it into the most fatal form, four dying in one family out five attacked.

The details of the investigations upon which these conclusions are based will l found in the accompanying reports of Surgeon Sternberg.

All of which is respectfully submitted.

S. M. BEMISS,
Member National Board of Health, New Orleans, La.
R. W. MITCHELL,
Member National Board of Health, Memphis, Tenn.

To the SECRETARY OF THE NATIONAL BOARD OF HEALTH,
Washington, D. C.

[Letter sent to Joseph Jones, M. D., President Louisiana State Board of Health.]

NEW ORLEANS, LA., *September* 13, 1880.

SIR: I respectfully call your attention to the accompanying report from Dr. G. M. Sternberg, regarding the disease at this time prevailing on the lower coast of the Mississippi River. In my opinion, the symptoms and mode of spread bear so close a resemblance to yellow fever that no time should be lost in applying all possible means to prevent its further spread. With a view to the accomplishment of this end, I have to inform you that you are authorized to draw upon the National Board of Health for such sums of money as may be necessary to procure disinfectants and to pay for the services of sanitary police and sanitary inspectors, and in truth all expenses expedient to the purposes mentioned. This money cannot be drawn from the Treasury except in payment of bills for services or articles, which bills must be duly authenticated. You will therefore make requisitions from time to time for such service, disinfectants, &c., as are in your opinion required, and forward same to me. This appropriation will apply to cases of infectious disease in this city, and in all places within the limits of the State which have no local boards to exercise such powers. The organization of the work will rest with yourself, subject to the approval of the National Board. You will therefore in all cases forward me the names of persons recommended to be employed, with pay of each, and one must take an oath of office, and have his name carefully entered upon blank pay-rolls which will be furnished you, and then on trouble will occur in regard to payments. It is well to remark that the Treasury Department refuses to pay for goods or clothing destroyed to prevent spread of disease, but will pay any reasonable expenses for cleaning and disinfectants.

S. M. BEMISS.

Dr. JOSEPH JONES,
President Louisiana State Board of Health.

Statement of Expenditures of the National Board of Health.

For what purpose.	During fiscal year ended June 30, 1880.	From April 1, 1879, to June 30, 1880.	During quarter ended September 30, 1880.	Total expenditures to September 30, 1880.
Furniture	$3,046 75	$3,667 64	$41 25	$3,708 89
Employés	16,966 31	18,644 41	4,450 39	23,094 80
Miscellaneous expenses	715 19	1,801 22	242 86	2,044 08
Rent, light, and fuel	2,072 08	2,072 08	212 40	2,284 48
Stationery	2,041 64	2,041 64	724 55	2,766 19
Pay and expenses for board	4,807 89	8,352 14	1,119 00	9,471 14
Pay and expenses of executive committee	4,210 78	4,210 78	1,440 20	5,650 98
Telegrams	1,678 84	1,707 55	96 11	1,803 66
Postage	878 76	966 01	....	966 01
Printing bulletin	5,412 76	5,412 76	2,147 89	7,560 65
Printing blanks, &c	1,469 97	2,139 96	172 65	2,312 61
Pay and expenses of inspectors	14,725 03	14,725 03	5,069 15	19,794 18
Miscellaneous investigations	9,571 24	9,571 24	849 73	10,420 97
Conference with sanitarium	178 25	178 25	....	178 25
Havana commission	11 408 15	12,333 84	662 30	12,996 14
T. J. Taylor, act. June 2, '79	540 00	540 00	....	540 00
Sanitary survey, Memphis, Tenn	5,925 35	5,925 35	....	5,925 35
Floating quarantine on the Mississippi River	40,238 11	40,238 11	9,988 39	50,226 50
Ship Island quarantine	18,988 89	18,988 89	11,737 28	30,726 17
Blackbeard Island quarantine	6,669 48	6,669 48	2,767 42	9,436 90
Report on yellow fever epidemic of 1878	1,800 00	1,800 00	....	1,800 00
Elizabeth River, Virginia, quarantine	3,812 16	3,812 16	2,317 75	6,129 91
Charleston, S. C., quarantine	38 60	38 60	40 20	78 80
Storage of tents, &c	....	....	260 75	260 75
Expended in State:				
Louisiana	16,571 45	16,571 45	1,490 00	18,061 45
Tennessee	52,111 42	52,111 42	....	52,111 42
Mississippi	16,125 84	16,125 84	770 63	16,896 47
Illinois	3,849 77	3,849 77	....	3,849 77
District of Columbia	7,710 00	7,710 00	....	7,710 00
Arkansas	7,720 01	7,720 01	....	7,720 00
Texas	535 00	535 00	125 00	660 00
Alabama	2,195 46	2,195 46	....	2,195 46
Florida	3,006 28	3,006 28	3,195 63	6,201 91
Georgia	246 20	246 20	....	246 20
Totals	266,762 16	275,908 57	49,921 58	325,830 10

APPENDIX B.

REPORT OF THE HAVANA YELLOW FEVER COMMISSION.

INSTRUCTIONS.

OFFICE NATIONAL BOARD OF HEALTH,
Washington, D. C., June 20, 1879.

The Havana Yellow Fever Commission of the United States National Board of Health met at 11 a. m.

Present: Drs. Stanford E. Chaillé and Geo. M. Sternberg, U. S. A., and Col. Thomas S. Hardee.

Dr. Chaillé was elected chairman.

The following memoranda of instructions were delivered to the commission by the secretary of the National Board of Health:

MEMORANDUM NO. 1.

Memorandum of instructions for a commission appointed by the National Board of Health to visit the island of Cuba for the purpose of investigating certain points connected with the prevalence of yellow fever in that island.

In organizing the commission to visit Cuba for the purpose of obtaining information with regard to yellow fever, the National Board of Health has more especially in view the following desiderata:

First. To ascertain the actual sanitary condition of the principal ports in Cuba from which shipments are made to the United States, more especially the ports of Havana and Matanzas, to determine how these sanitary conditions can best be made satisfactory, and more especially as to what can and should be done to prevent the introduction of the cause of yellow fever into the shipping of these ports.

Second. To increase existing knowledge as to the pathology of yellow fever, that is, as to the changes and results which it produces in the human body.

Third. To obtain as much information as possible with regard to the so-called endemicity of yellow fever in Cuba, and the conditions which may be supposed to determine such endemicity. This, of course, involves a careful examination of neighboring localities where the disease does not appear to have its cause permanently localized.

The three points above referred to are believed to be those which will most certainly yield results to scientific investigation, and which therefore should receive the special attention of the commission.

But in addition to these the National Board of Health desires that the commission shall consider problems relating to this disease—problems which may be entirely insoluble, but which, nevertheless, are of such importance that an effort should be made to decide whether the National Board of Health will be justified in undertaking the labor and expense which will probably be required to obtain anything like a complete solution of them, if such solution is at all possible. These problems relate to the nature and natural history of the cause of yellow fever; and the most important preliminary investigation on this point is to ascertain some means of recognizing the presence of the immediate cause of yellow fever other than the production of the disease in man. These means might, for example, be the production of some special phenomena in some of the lower animals, or it might be the finding of a special microdeme in all yellow-fever cases and no others.

It is obvious that if it be found possible to produce some specific symptoms in some one of the lower animals by exposing such animals in localities known to be capable of producing the disease in man, and thus to establish a physiological test of the presence of the cause of the disease, we may even hope to be able to determine the nature of and the natural history of this cause, although prolonged investigation may be necessary to effect it.

With the time and means which the National Board of Health can at present put at the disposal of the commission, no complete investigation is possible; all that is hoped for is that the commission will be able to obtain some grounds for apositive opinion as to whether it is probable that such an investigation would put us in possession of the test referred to.

It is not proposed to go into details as to the modes of attacking this problem; l one thing is insisted on, and that is, that as far as possible what is done shall be done and so recorded that it need not be done again hereafter.

It is expected that the commission will organize itself and devise for itself the me ods and order of carrying out the work above indicated. It is desired that the rep to be furnished the Board shall be made by the members jointly as a commission a not as individuals. In other words, it is expected that each member will be care to verify the results obtained by the other members, or to note distinctly the abser of such verification.

J. L. CABELL,
President National Board of Health.

THOMAS J. TURNER,
Secretary.

MEMORANDUM NO. 2.

The object of the investigation is to gather, digest, and arrange in a form convenie for use, all information respecting yellow fever, which shall prove practically valuab to health authorities in excluding the disease from this country and in extinguishin those outbreaks which do occur.

In order to secure this end as effectually as possible, the commission should attac a special importance to those facts and observations which enlarge our knowledge o the essential nature of the cause of yellow fever.

Every available method should be employed to prosecute this point of study to th greatest attainable degree of success.

1st. Efforts should be repeatedly and patiently made to study the specific cause o yellow fever in an objective manner, by means of the microscope and microphotographs. Examinations should be made: (*a*) of matters obtained by condensing or filtering atmospheres of both infected and non-infected places; (*b*) of fluids exposed to infected atmospheres, as water, milk, oils, butter, &c.; (*c*) of dust and textile fabrics from infected rooms or places; (*d*) of all fluids or products of the human body under attacks of yellow fever; (*e*) of such solid structures as usually exhibit a tendency to become implicated in the pathology of yellow fever, as the mucous membrane of the stomach, the liver, kidneys, &c.; (*f*) of structures, fluids, and excreta of inferior animals exposed to yellow-fever infection or treated with products of yellow-fever patients; (*g*) of atmospheres and fluids in which attempts have been made to cultivate yellow-fever germs of infection; (*h*) of such microzoa and microphyta as are found associated with or around yellow-fever cases, with a view of ascertaining some of the leading points connected with their development and life cycles.

2d. Physical and chemical examinations of the atmosphere, water, &c., of infected and non-infected localities, noting especially organic material and ozone present.

3d. Investigations into any alleged facts or observations which support the opinion that yellow-fever poison is cognizable by any human sense.

The commission is also expected to make a careful study of the natural history of the yellow-fever poison, as shown in its habitudes and behavior in its supposed endemic home: (*a*) the circumstances and conditions which are necessary, or which appear most favorable to its reproduction or evolution, should be examined; (*b*) also, its field of reproduction to discover if it be within or without the human system, or both; (*c*) period of incubation; (*d*) duration of its vitality or virulence; (*e*) those influences which cause the disease to assume distinct epidemic forms in climates where no frost ever occurs; (*f*) alleged perennial life of the poison in localities said to be permanently infected; (*g*) into means of distinguishing infected localities from non-infected; (*h*) into the supposed *de novo* origin of the contagion; (*i*) any facts showing its admission into the system by other avenues than the atmosphere.

Cases of yellow fever should be verified by observations of some of the clinical phenomena, and by autopsies, where permissible, when they prove fatal.

Efforts should be made to formulize a histological pathology of yellow fever.

The influences of the following conditions and surroundings upon the origin and spread of yellow fever, and the following facts concerning it, should be carefully noted:

1st. Climate and meteorological states and changes; 2d. Sanitary conditions of localities; 3d. Permanently infected places; 4th. Personal intercourse; 5th. Circumstances, if any, under which the disease is most communicable or contagious; 5th. Fomites; 7th. Personal hygiene; 8th. Age, sex, or condition of system as affecting liability to attacks; 9th. Height above sea; 10th. Quarantine; 11th. Second attacks; 12th. Liability of different races; 13th. *De novo* cases; 14th. Mortality of various places, occupations, sex, &c.; 15th. Range between the lowest rate of endemic prevalence and highest rate of epidemic prevalence; 16th. Connection between yellow fever and other diseases; connection between yellow fever and sickness of inferior animals, either received naturally or by experimentation.

REPORT TO THE UNITED STATES NATIONAL BOARD OF HEALTH ON YELLOW FEVER IN HAVANA AND CUBA BY STANFORD E. CHAILLÉ, A. M., M. D.*

Salus populi, lex suprema.

TABLE OF CONTENTS.

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*Chairman of the Havana Yellow Fever Commission of the United States National Board of Health; corresponding member of the Academia de Ciencias Medicas, &c., of Habana, Cuba; honorary fellow of the College of Physicians, Philadelphia; honorary member of the Medico-Chirurgical Faculty of Maryland; professor of physiology and pathological anatomy Medical Department University of Louisiana, &c., &c.

LIST OF STATISTICAL TABLES.

LIST OF STATISTICAL TABLES.—Continued.

ABBREVIATIONS AND EXPLANATIONS.

Wherever a dash is used to connect two dates, *e. g.* 1851-1878, both dates specified are included, and all the intervening period of time. All death-rates are per 1,000 population. Pop. an., and y. f. have been sometimes used for population, annual, and yellow fever.

Table of such equivalent measures and weights, in English, and in the French metrical system, as are used in this report.

1 kilogramme	= 2.2 pounds, avoirdupois.	1 pound, avoirdupois	= .45 kilogram.
1 millimeter	= .03937 inch.	1 inch	= 25.4 millimeters.
1 meter	= 3.28 feet.	1 foot	= .3048 meter.
1 meter	= 1.1 yards.	1 yard	= .9144 meter.
1 kilometer	= .62 mile.	1 mile	= 1.61 kilometers.
1 sq. meter	= 10.764 square feet.	1 square foot	= .093 square meter.
1 cubic meter	= 36.3 cubic feet.		

Acres: Square meters, if divided by 4046.8, are reduced to acres; 1 acre = .4 hectare, and 1 hectare = 2.47 acres.

Gallons: Cubic meters, if divided by 264.17, are reduced to the American standard gallons of 231 cubic inches each; and if divided by 220.1, are reduced to the English standard imperial gallons of 277.274 cubic inches each.

NEW ORLEANS, LA., *August* 27, 1880.

Secretary of the National Board of Health:

DEAR SIR: The Havana Yellow Fever Commission, which was organized on June 20, 1879, and returned to the United States October 9, after only three months' labor in Cuba, presented its preliminary report, prepared by the chairman and secretary, on November 18, 1879.

In compliance with the general instructions of your board, which required "each member to make a detailed report of his own work in the investigation," and in compliance also with your special notice of October 16, 1879, requesting me to prepare a final report, this is herewith submitted, and has reference more particularly to the subjects which were especially assigned to me for investigation, viz, to "the sanitary condition" and to the "so-called endemicity" of yellow fever in the principal ports of Cuba. Although this report is due directly to three months of special investigation in Cuba, yet the views expressed and the conclusions arrived at have been controlled, in many instances, by the personal experience derived from six violent epidemics, by annual familiarity with the disease during twenty-one of the past twenty-eight years, and by the greater interest taken, for many years, in the prevention than in the cure of the disease.

Yours, very respectfully,

STANFORD E. CHAILLÉ, M. D.

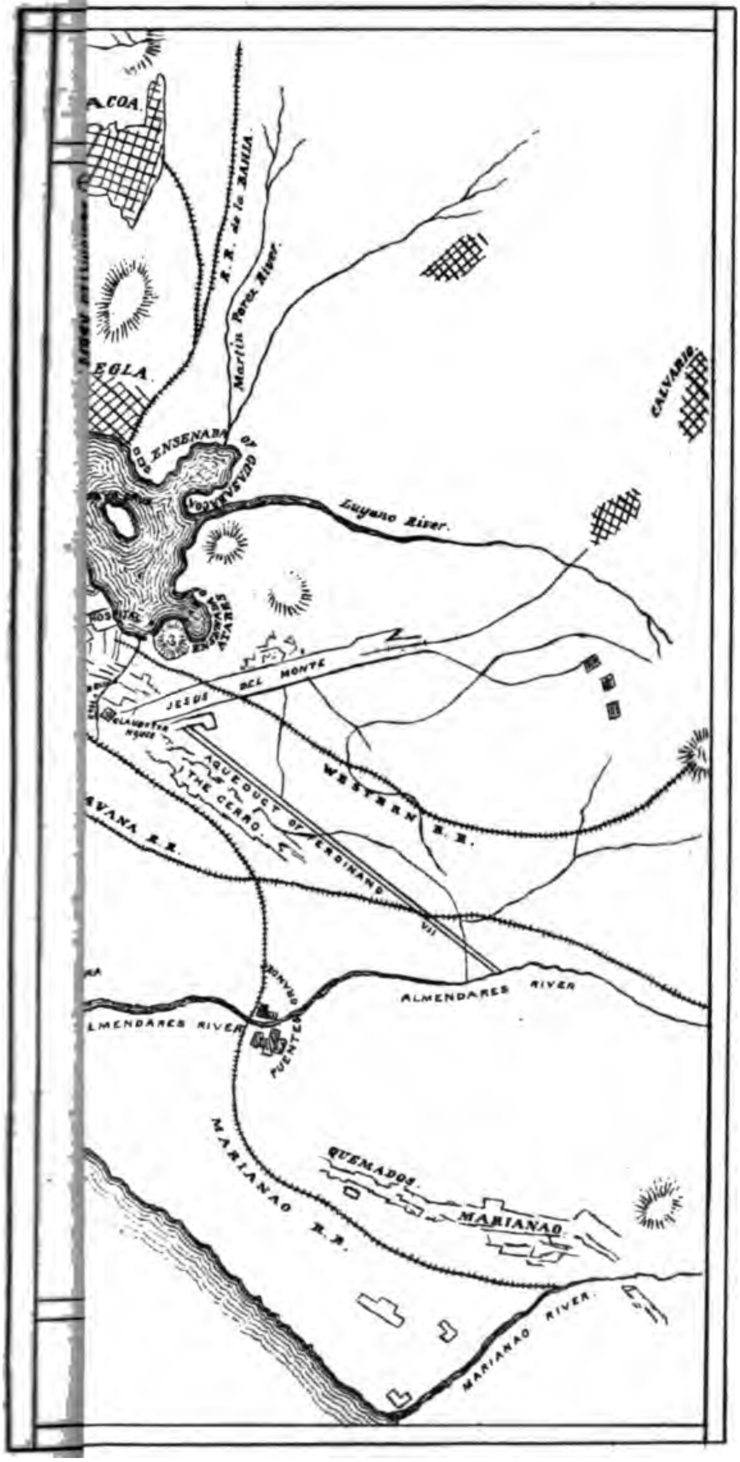
INTRODUCTION.

As nations advance in civilization, their efforts must necessarily increase to lessen the destruction of life and property caused by avoidable diseases. Among other means to this end, it will often become necessary to organize commissions, or expeditions of experts, to visit those places where migratory diseases can be best studied, or be best controlled. Hence, not only for present interest, but also for the benefit of future commissions, a brief account will be given of the means adopted to execute, and of the difficulties encountered in executing, the duties assigned to the Havana Yellow Fever Commission, and more especially those which fell to my own lot. A greater historical interest may be attached to such a recital for the reason that, while our great nation has equipped various learned expeditions and experts to mitigate the ravages inflicted by parasites and disease on its agricultural products, such as its cereals and cotton, and on its domestic animals, such as its hogs, yet, only in 1879 did its enlightenment reach such a stage that it organized the Havana Yellow Fever Commission—the first expedition ever organized by the Government of the United States for the purpose of better protecting the health and lives, and therewith the wealth and prosperity, of its human inhabitants from disease.

Sailing from New York on July 3, the commission arrived in Havana on the 7th. On July 15 the following official circular, translated into the Spanish language, was published in a medical journal, and in the form of a pamphlet was widely distributed:

"THE HAVANA YELLOW FEVER COMMISSION OF THE UNITED STATES NATIONAL BOARD OF HEALTH.

"In 1878 yellow fever visited more than one hundred cities and villages in the United States, especially afflicting the States of Louisiana, Mississippi, and Tennessee. More



ACOA.
R. R. de la BAHIA
Martin Perez River
EGLA.
ENSENADA OF GUASABACOA
Luyano River.
CALVARIO.
HOSPITAL
ENSENADA ATARES
JESUS DEL MONTE
SLAUGHTER HOUSE
AQUEDUCT OF FERDINAND VII
THE CERRO
WESTERN R. R.
AVANA R. R.
ALMENDARES RIVER
LMENDARES RIVER
PUENTES GRANDES
QUEMADOS.
MARIANAO.
MARIANAO R. R.
MARIANAO RIVER.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Cayo Coco
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Moron
Arroyo Blanco
Ciego de Avila
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than 120,000 persons sickened, more than 20,000 died, and the pecuniary loss to the country exceeded, by the lowest estimates, one hundred millions of dollars, in gold. This vast destruction of life and property induced Congress to enact, March 3, 1879, a law which established the National Board of Health, and appropriated $50,000 for its use. On June 2, 1879, Congress made an additional appropriation of $500,000, designing that this sum should be chiefly used in aiding the various State boards of health.

"The first thing of moment decided upon by the National Board of Health was to organize a commission to visit the West Indies, for the purpose of investigating yellow fever at its reputed perpetual home. The hope is entertained that by long-continued scientific research into special questions relating to this disease, its mysterious problems may be eventually solved and its ravages be controlled; and it is believed that if mankind is ever to be protected from this scourge this must be accomplished by stamping it out at its very sources.

"The present commission will remain three months in Cuba, and will, it is hoped, be followed by others, either to Havana or Rio, or other locality where apparently yellow fever prevails habitually. Strong hope is entertained that this warfare against disease by science, organized and endowed by a great nation—instead of a warfare, as everywhere heretofore, by unaided volunteers—will soon become an international work, in which representatives of the United States National Board of Health may unite with their professional brothers of every civilized nation, and, hand in hand with these, march forward in the grandest contest yet undertaken by civilization; not in a selfish contest for the good of any one nation, but in behalf of humanity.

"The commission is composed as follows, viz:

"*Chairman.*—Prof. Stanford E. Chaillé, M. D., of New Orleans, La.

"*Secretary.*—Dr. George M. Sternberg, M. D., surgeon, U. S. Army.

"*Members.*—John Guitéras, M. D., of Philadelphia, Pa.; Mr. Thomas S. Hardee, civil engineer, of New Orleans, La.

"*Employés.**—Mr. Henry Mancel, photographer; Mr. Rudolpho Matas, clerk."

The official instructions to the commission, received June 20, 1879, are as follows:

"In organizing the commission the National Board of Health has more especially in view the following desiderata:

"First. To ascertain the actual sanitary condition of the principal ports in Cuba from which shipments are made to the United States, more especially the ports of Havana and Matanzas; to determine how these sanitary conditions can best be made satisfactory, and more especially as to what can and should be done to prevent the introduction of the cause of yellow fever into the shipping of these ports.

"Second. To increase existing knowledge as to the pathology of yellow fever, that is, as to the changes and results which it produces in the human body.

"Third. To obtain as much information as possible with regard to the so-called endemicity of yellow fever in Cuba, and the conditions which may be supposed to determine such endemicity. This of course involves a careful examination of neighboring localities where the disease does not appear to have its cause permanently localized.

"The three points above referred to are believed to be those which will most certainly yield results to scientific investigation, and which therefore should receive the special attention of the commission.

"But in addition to these the National Board of Health desires that the commission shall consider certain problems relating to this disease; problems which may be entirely insoluble, but which nevertheless are of such importance that an effort should be made to decide whether the National Board of Health will be justified in undertaking the labor and expense which will probably be required to obtain anything like a complete solution of them, if such solution is at all possible. These problems relate to the nature and natural history of the cause of yellow fever, and the most important preliminary investigation on this point is to ascertain some means of recognizing the presence of the immediate cause of yellow fever other than the production of the disease in man. These means might, for example, be the production of some special phenomena in some of the lower animals, or it might be the finding of a special microdeme in all yellow-fever cases, and no others. It is obvious that if it is found possible to produce some specific symptoms in some one of the lower animals by exposing such animals in localities known to be capable of producing the disease in man, and thus establish a physiological test of the presence of the cause of the disease, we may even hope to be able to determine the nature and the natural history of this cause, although prolonged investigation may be necessary to effect it.

"With the time and means which the National Board of Health can at present put at the disposal of the commission no complete investigation is possible. All that is

*During a part of its sojourn in Cuba, the commission found it indispensable to employ also Dr. Abraham Morejon as an interpreter and assistant, and Mr. Richard I. Cay, as a translator; both are residents of Cuba.

hoped for is that the commission will be able to obtain some grounds for a posi opinion as to whether it is probable that such an investigation would put us in session of the test referred to.

"It is not proposed to go into details as to the modes of attacking this probl but one thing is insisted on, and that is that as far as possible what is done shall b done and so recorded that it need not be done again hereafter.

"It is expected that the commission will organize itself and devise for itself methods and order of carrying out the work above indicated. It is desired that report to be furnished the Board shall be made by the members jointly as a comm sion. In other words, it is expected that each member will be careful to verify t results obtained by the other members, or to note distinctly the absence of such ve fication.

"J. L. CABELL, *President*.

"THOMAS J. TURNER, *Secretary*."

In addition, the commission was further instructed, June 26, 1879, "It is the wi of the National Board of Health that the work specified under the preceding sever distinct heads should engage the earnest attention of all members of the commissio until such work is completed, to the exclusion of all other lines of investigation—such for example, as the clinical observation and record of cases."

Attention is particularly solicited to the facts that, as officers charged with the ex cution of special instructions, it becomes the imperative duty of the members of th commission to confine their labors to four distinct and specific subjects of investiga tion; and, therefore, that any such aid as the authorities and the learned physician of Cuba may feel disposed generously to give should be limited to these four subjects The proper investigation of these will so fully occupy all the time of the members o the commission that they prefer, at least for the present, to throw entirely aside all o the many other subjects of interest relating to yellow fever.

His excellency the governor-general has received the commission with distinguished consideration, recognized that its high mission is to serve not one but all nations, and has zealously proffered every aid in his power. The commission profoundly appreciates this action of his excellency. In behalf of the military authorities, Dr. Juan Lopez de Ochoa, medical director of the army, and Dr. A. Pardiñas, medical director of the military hospitals in Havana, and in behalf of the civil authorities Dr. V. L. Ferrer, secretary of the Cuban superior board of health, and Dr. L. M. Cowley, secretary of the Havana municipal board of health, have kindly and earnestly offered the commission all the aid it may request. In addition, the distinguished physicians of Havana, in number too large for detailed mention, have vied with each other in welcoming the commission, and in tendering offers of assistance.

Inasmuch as the commission is most anxious that its labors should result in honor to medical science, and in practical good for mankind, it desires to utilize all the aid offered, and to accomplish this deems it well to explain by this publication, which becomes the more necessary since, unfortunately, most of the members do not speak Spanish, the special points which it is proposed to investigate in the execution of its general official instructions. By these details it is designed to indicate to all who would aid the commission the direction in which their aid will prove serviceable. In this connection it may now be stated, that on every point to be investigated precise, well proven facts, not opinions, are sought for; that the facts specially desired are those obtained by personal observation, and not those obtained by "hearsay" either from other persons or from books; and that it is very desirable the facts should be presented in writing.

It will be observed that the commission is instructed to strive "to increase existing knowledge as to the pathological anatomy of yellow fever," and "to investigate the nature and natural history of the cause of yellow fever." The investigation of these subjects has been assigned to Drs. Sternberg and Guitéras, who propose to attack these problems, in large part, through the microscope. The histological pathology of yellow fever will alone be specially studied; and, in addition, the microscope will be used in efforts to disclose the ultimate cause or germ of the disease. For these investigations the commission is supplied with the best lenses the world affords, and with a photographer and micro-photographic instruments, for the purpose of magnifying largely and of representing pictorially all which these lenses may disclose, thus rendering these disclosures the common property of the scientific world. Still further, attempts will be made to communicate yellow fever to unacclimated animals from New York, by exposing them to specially infected localities, by inoculation of the blood of persons sick with yellow fever, and by all other probable means. Drs. Sternberg and Guitéras will need no aid for these investigations other than such use of the hospitals as may be necessary to secure cadaveric specimens, as promptly after death as possible, and the blood, &c., of those suffering with yellow fever. However, it may be added, that the commission would be obliged for any accurate information tending to prove

that the prevalence of yellow fever is associated with any phenomena in the animal or in the vegetable kingdom.

The remaining two subjects for investigation the commission has assigned to the chairman, Dr. Chaillé, and to Mr. Hardee.* These members will find it impossible to prosecute successfully their work unless largely aided by the military and civil authorities, as well as by physicians. The two subjects which Dr. Chaillé and Mr. Hardee are required to investigate are, for convenience, subdivided into the following four heads, under each of which is detailed, in the form of questions, the special set of facts deemed necessary to throw light upon each one of these four heads:

I. "Ascertain the actual sanitary condition of the principal ports in Cuba from which shipments are made to the United States, more especially the ports of Havana and Matanzas."

1. What is the condition at these ports of the air, water, soil, streets, houses, latrines, drainage, harbors, adjacent swamps, &c., and what is their geological structure?

2. What is the annual death-rate at these ports?

3. What is the annual number (by months) of the vessels which sail from the various ports of Cuba to the various ports of the United States.

II. "Determine how these sanitary conditions can best be made satisfactory, more especially what can and should be done to prevent the introduction of the cause of yellow fever into the shipping of these ports."

1. What can and should be done to improve the sanitary condition of these towns and of their harbors?

2. What preventive measures can and should be adopted by every vessel in an infected port? What is the nature of the ballast, cargo, &c., transported by vessels to other ports?

3. What preventive measures can and should be adopted by every person en route from infected to non-infected ports?

4. What well established facts can be produced to determine with precision the period of incubation of yellow fever?

5. What facts can be contributed by experience in Cuba to prove what influence, if any, is exercised in limiting the extension of yellow fever by quarantine, and by seclusion or isolation of those sick with the disease?

III. "Obtain as much information as possible with regard to the so-called endemicity of yellow fever in Cuba."

1. What are the statistics of population by every census ever taken; and the annual statistics (by months) of deaths, as full and as far back in time as possible, especially as to yellow fever, and as to Havana and Matanzas? Statistics are desired not only of these cities, but also of the hospitals and other public institutions. Mortality statistics of yellow fever especially are sought, not only by years and months, but also by age, sex, race, nationality, occupation, and condition. With such statistics there are also needed the number of the population in which the mortality occurred, and, if possible, the number of those acclimated and unacclimated in said population.

2. In what years have epidemics of yellow fever, cholera, small-pox, &c., occurred; the dates of the first and last cases; the degree of fatality?

3. What influence on epidemics has been exercised by any such causes as inundations, hurricanes, earthquakes, upturnings of the soil, the making of new ground, the mixture of fresh and salt water, war, sieges, migrations?

4. What is the history of yellow fever in Cuba, and especially in Havana, since its first appearance? Has yellow fever ever disappeared from Cuba or from Havana? In what years has there been no yellow fever yet numerous unacclimated immigrants?

IV. "Obtain as much information as possible with regard to the conditions which may be supposed to determine the so-called endemicity of yellow fever in Cuba. This, of course, involves a careful examination of neighboring localities where the disease does not appear to have its cause permanently localized."

1. What meteorological records can be secured for various places in Cuba? Does frost occur in Cuba; if so, what influence does it exercise on yellow fever, and what is the influence of temperature, humidity, storms, electricity, ozone, currents of air, night air, and the sun's rays?

2. What places in Cuba are infected by yellow fever, either persistently, generally, rarely, or never? What special parts of Havana, Matanzas, &c., are most and what parts least often and severely infected? What parts of these cities and what places in Cuba have the most and the least numerous unacclimated population? Are there any houses or plantations "on the sea, even near Havana, which are never infected," although inhabited by the unacclimated?

*Col. T. S. Hardee did not report for duty in Cuba until August 18, and returned to the United States on the following September 20; this brief visit, together with continued ill health, and his death, May 21, 1880, resulted in depriving the chairman of any contributions from him to the matter in this report.

3. What differences can be observed between the places persistently, rarely, or never infected?

4. Do the first cases generally occur on or near the shipping, and are there any special localities where the disease is prone first to appear?

5. Is yellow fever ever transmitted to any non-infected localities and there propagated? Is it ever communicated, outside of infected localities, from person to person?

6. Does the disease follow the lines of traffic and travel? If so, what persons or things, or fomites, best convey the poison? Is yellow fever a fæcal or excrementitious disease?

7. Are there any instances in Cuba of convents, asylums, or barracks—located within an infected district, inhabited by the unacclimated, and rigidly maintaining non-intercourse—which have escaped yellow fever?

8. Are Cubans who reside in places where yellow fever does not prevail liable to the disease? To what is acclimation due, and is it ever lost?

The commission fully understand that it will be impossible to secure satisfactory answers to some of the questions now detailed, but it is none the less its duty to obtain all the facts on these topics which can be gathered by personal investigation and by diligent inquiry.

The commission and its laboratory is located at the Hotel San Carlos, where visitors will usually find the members, from 7½ to 9 p. m., on every evening except Thursday.

Finally, the commission desires it understood that, while its members are citizens and officers of the United States, they do not seek the aid of the authorities and of the physicians of Cuba in the name of their nation so much as in the paramount interests of public hygiene, and in the name of science and humanity.

STANFORD E. CHAILLÉ, *President.*
G. M. STERNBERG, *Secretary.*

HAVANA, CUBA, *July* 15, 1879.

In addition to the publication of this document, other measures were taken which facilitated the commission in the better execution of its instructions. To aid it, the governor-general, about July 20, appointed an auxiliary commission of eminent Spanish and Cuban physicians. In future the two commissions will be designated the United States Commission and the Spanish Commission. With the co-operation of the Spanish Commission, two very brief circulars of interrogatories were published and distributed, in connection with the one above quoted, to United States consular officers, to the civil authorities, and to the most prominent physicians in the most important sea-ports and inland towns of Cuba. Although the official instructions designated only ports of entry as the places to be investigated, it was manifest that an investigation thus limited would run the risk of presenting a partial and false view of the prevalence of yellow fever in Cuba; hence, some information was gathered and is presented in this report in respect to not only Cuba's fifteen ports of entry, but also thirty-four other places, six located on the sea-shore and twenty-eight inland. By these means, and by the sedulous collection of medical and all other publications likely to contribute any historical or other information of value to the United States Commission, a much larger mass of trustworthy data was secured than would otherwise have been possible. Personal inspection was as thorough and extensive as was practicable in an island where only three months was to be passed, and where it requires not less than ten days of travel between some of the most important points, such as between Havana and Santiago de Cuba. Therefore, the only places personally inspected were as follows: Havana, with its thirty-six wards; the adjacent towns of Regla, Guanabacoa, Marianao, and San José de las Lajas, and the sea-ports of Matanzas, Cardenas, and Cienfuegos. In addition, while traveling between these places, many towns of importance, such as Batabano, Bejucal, Colon, and Jaruco, were sufficiently well seen to contribute to a more correct view of the sanitary condition of Cuba as a whole.

The difficulties encountered in the execution of my duty were numerous, harassing, and of such nature that a thoroughly satisfactory discharge of this duty was impossible. Some of these difficulties, with their resulting defects, will be mentioned.

Whoever is destitute of a like experience would find it very difficult to realize the waste of time, the absurd misapprehensions, and the numerous other vexatious impediments which fall to the lot of him whom duty forces to confer with a large number of strangers, through interpreters and translators, on scientific topics, which are often not comprehended by either the interpreter or by the stranger from whom the facts are being solicited. A sanitary officer in a foreign country should have a thorough knowledge of the language of the country.

Such problems as the sanitary condition of a country, the prevalence there of a special disease, its causation and prevention, necessitate for their solution, among other facts, those furnished by vital statistics. Since Cuba has a superior board of health and numerous municipal and local boards, it would be presumed that much valuable information and trustworthy statistics could be procured from these. But, unfortu-

nately, there is no need for a citizen of the United States to visit Cuba to learn the painful lesson that boards of health may be merely nominal bodies organized by laws which leave them destitute of resources and of power, and often ludicrously lacking in everything, even a book of record, which should characterize such bodies. While boards of health in Cuba are generally composed of physicians who personally deserve respect and confidence, yet it was not my good fortune to see or hear anything to the credit of these boards, and, as "corporations have no souls," instances could be given proving conclusively that Cuban boards of health have, as to bills of health and other sanitary matters, most elastic consciences. So little are vital statistics appreciated, that, if gathered by some zealous student, they must be published, if at all, at private expense. Even the hospitals under government control publish no reports, nor do they, for the most part, even possess any records of value to the sanitarian; without great expense and delay often nothing can be furnished, except a bare memorandum of total admissions and discharges. The churches, as in other Catholic countries, keep records of all deaths and baptisms, but these are in the hands of ecclesiastics, who fail so completely to appreciate their sanitary value that the only discourtesies and rebuffs shown in Cuba to the United States commission resulted from courteous efforts to obtain from some of these ecclesiastics a simple memorandum of annual deaths and baptisms.

In consequence of this lack of vital statistics it was found that Cuban physicians have very little accurate knowledge of the sanitary condition of their own country, and often entertain most erroneous ideas, even as to the very town in which they live; and, of course, the general public is even more ignorant, clinging obstinately to the popular prejudice in favor of the salubrity of one's home. For such reasons the difficulties in procuring in Cuba trustworthy information and accurate statistics were unusually great. The numerous statistical tables in this report were, in greater part, obtained by the aid of the government, and were presented in manuscript. The data thus obtained have been much abbreviated by laborious compilation, and are now published for the first time. Though defective and at times discrepant, the vital statistics now published are not only the best which could be procured, but also the best and most extensive which have ever been published, and they furnish more accurate knowledge, with all their defects, of the true sanitary condition of and the prevalence of yellow fever in Cuba than can be obtained from any other source whatever.

Many reports of value were received from consuls and physicians, and, through the Spanish commission, from boards of health and other civil authorities. From some places of importance reports, though solicited, were not obtained, and the reports which were received from some other places were of little value. Others, again, were not received until the commission was about to leave Cuba, or even until it had returned to the United States; in fine, too late to secure the additions and explanations desirable. The information extracted from these reports repeatedly falls short of what was sought for, and therefore what is published represents only what it was found practicable to procure. In every case, care has been taken to present the statements and views of the authors of these reports with fidelity, especially when at variance with my own.

The hope had been entertained that much more information than was secured would be obtained from Cuban physicians respecting the numerous points involved in the subjects assigned me for investigation. But it was found that in Cuba all have become by habit so hardened to the devastating prevalence of yellow fever that even the physicians have become comparatively indifferent to the study of the prevention of that which seems to be inevitable. Hence, their chief interest in and knowledge of yellow fever concerns its diagnosis and treatment, while little study has been given to the questions which refer to its causation and prevention. Notwithstanding this, it is very observable that there is in Cuba as much difference of professional opinion respecting the diagnosis of yellow fever as elsewhere, and also that the ratio of deaths to cases is just as high. Hence, there was nothing new to be taught by Cuban physicians, even as to their favorite topics—diagnosis and treatment.

In addition to the foregoing special difficulties encountered in discharging the duty assigned, there were some general ones which deserve to be better understood by the public, as well as by many physicians. Parkes teaches that "no disease is worth studying scientifically, as to causes and prevention, until its diagnosis is quite certain." Even if this be an exaggeration, it certainly is true that, apart from such additions to our knowledge as may be contributed by researches such as can be prosecuted in microscopical and chemical laboratories, little progress in our knowledge of yellow fever can be reasonably expected until the diagnosis of the disease is perfected, and until vital statistics and public hygiene, with well-trained sanitary inspectors, contribute their indispensable aid in furnishing the additional premises which are indispensable to additional conclusions. Of these five indispensable things, the future must depend on the progress of science to furnish the microscopy, chemistry, and diagnostics, but it can look only to the progress of civilization in yellow-fever regions to furnish the necessary vital statistics and public hygiene. Experts fully understand

our deficiencies in these five great needs, and the unavoidable results thereof; but ill are they appreciated by the public, and, alas! by many physicians, that the m absurd views and hopes were entertained by many as to what should and would accomplished by the United States commission. Unreasonable hope is the parent unreasonable disappointment, and this unfortunately discourages the efforts necess to prosecute perseveringly and vigorously the warfare against pestilence—a warfa which deserves from the nation as much patriotism, intelligence, and self-sacrifie and as thorough organization as would be given to a warfare against much less destru tive human foes. The members, neither of the National Board of Health nor of t commission indulged in any illusive hopes; and well understood that the great prol lems of yellow fever, viz, the nature of its poison its propagating causes, and therewit knowledge and control of its growth and dissemination, are equally the problems other migratory diseases, as well as of many vegetables and animals; and that th solution of these problems will very surely require the prolonged and arduous labo of many in various fields of research.

Cuba, as its prosperity and commerce increased, has become the greatest nurser and camping ground of one of man's most ruthless destroyers. Itself most sorel afflicted, it annually disseminates to other lands, as from a central hell, disease and death. The United States Havana Yellow-Fever Commission was sent more especiall as an expedition of scouts to inspect the stronghold of an invisible, invincible, and, in much, an incomprehensible foe, and to report all such facts as might lead to a better knowledge, and thereby to a more successful defensive warfare against this foe. Had the nation human enemies possessing like characteristics, no knowledge of their country or of their conduct would be deemed too minute or superfluous; and, in this light, the present report on yellow fever has been written.

It is believed that while this report is destitute of the record of any wonderful discovery, it none the less will tend to correct many errors, to strengthen some truths, and to suggest some special researches; and inasmuch as it contains more information of yellow fever in Cuba, not only more reliable but also covering a longer period of time and a greater extent of the island than ever before published, it is also believed that this report will prove of historical value, serving as a standard for the comparison of yellow fever as it may prevail in the future with its prevalence in the past. From this much future good may ensue. Cordially welcomed and assisted by the government and the medical profession of Cuba, effort has been made to repay, in part, the favors conferred, by writing a report which might prove as serviceable to Cuba as to the United States. As a result, many statistical and other details have been recorded, which may be deemed superfluous in the one country, but valuable in the other.

Among the many noble physicians and citizens of Cuba, a sufficient number furnished laborious and valuable reports to cover more than one thousand pages of manuscript; and this fact, in connection with the statement that this final report much exceeds the limits expected and desirable, will, it is hoped, explain to their satisfaction why their reports have not been published in full, and only such extracts made therefrom as seemed to be most appropriate to the subjects herein treated.

ARRANGEMENT OF REPORT.

Inasmuch as the preliminary report and this present final report are both in response to the same unaltered official instructions, the former, so far as it treats of the subjects assigned me for investigation, is herewith republished, with many corrections and additions, and is designed to constitute brief and direct replies to the special inquiries detailed in the instructions. Succeeding these first seven chapters, subjects subordinate to or illustrative of the views and conclusions previously presented are considered in the following fourteen chapters, VIII–XXI.

Finally, statistical tables and reports concerning special subjects and places constitute what is usually termed an appendix, which presents in detail numerous facts tending to prove the correctness of views and conclusions maintained in preceding parts of this report. However, the report, for convenience and brevity of reference, is subdivided, not by an appendix, but only in chapters, and these seventy-six chapters, with the ninety-six tables contained therein, are enumerated continuously from the beginning to the end.

Vigorous effort has been made to avoid hasty deductions from inconclusive premises, and, though mentally burdened with the multiplicity of details, to grasp their significance in the aggregate. All the requisite premises, so far as known to me, have been placed side by side the conclusions, thus enabling the reader to protect his judgment from the author's errors, and perhaps to deduce from the facts other conclusions of moment which may have been overlooked by him.

LIST OF CONTRIBUTORS.

The addresses of those in Cuba who have contributed important assistance in obtaining the information recorded in this report are as follows:

Don Ramon Blanco, marquis of Peña Plata, governor-general of Cuba.

Mr. Henry C. Hall, United States consul-general at Havana.
Dr. Daniel M. Burgess, United States sanitary and quarantine inspector at Havana.

MEMBERS OF THE AUXILIARY SPANISH COMMISSION.

Dr. M. Astray de Caneda, of the Spanish navy, president.
Dr. E. Nunez de Villavicencia, medical director of the civil hospital, secretary.
Dr. V. L. Ferrer, secretary superior board of health.
Dr. Carlos Finlay, member of the Academy of Sciences.
Dr. Raphael Fleitas, director of the Military Health Park.
Dr. S. Gallardo, professor of clinical medicine, University of Havana.
Dr. J. G. Lebredo, member of the Academy of Sciences.
Dr. Antonio Pardiñas, medical director of military hospital at Havana.
Dr. F. F. Rodriguez, professor of anatomy, University of Havana.
Dr. Casimiro Rouro, staff officer of the governor-general.
Dr. V. B. Valdez, member of the Academy of Sciences.
Dr. Francisco Zayas, member of the Academy of Sciences.

The following gentlemen, located, as are those above, in Havana and in other parts of Cuba, also rendered important services:

Mr. Antonio Ariza, city architect	Havana.
Mr. J. Carbonell y Marti	Havana.
Don Rafael Ceréro, commandant of engineers	Havana.
Mr. A. Conde	Havana.
Mr. A. Gonzalez y Herrera, city architect	Havana.
Dr. P. Selsis	Havana.
Mr. A. H. Taylor, civil engineer	Havana.
Rev. B. Viñes, director of the observatory of the College of Belen	Havana.
The editors of the Anales de la Academia de Ciencias Medicas, &c	Havana.
The editors of the Crónica Médico-Quirúrgica	Havana.
The editors of the Gaceta Médica	Havana.
Dr. J. J. Rabeiro	Bahia Honda.
Dr. P. Imanes	Baracoa.
Mr. A. M. Zamora, United States consular agent	Baracoa.
Dr. F. R. Olivera	Bejucal.
Dr. Pedro Rou	Bejucal.
Mr. J. G. Fuentes, United States consular agent	Caibarien.
Dr. Antonio Lopez	Caibarien.
Dr. J. A. Pacetti	Cardenas.
Mr. J. H. Washington, United States consular agent	Cardenas.
Dr. Ramon de Mazarredo	Cienfuegos.
Dr. W. W. Cross, United States vice-consul	Cienfuegos.
Dr. A. R. Campeña, secretary board of health	Cuba, or Santiago de Cuba.
Mr. J. Canizares, secretary civil government	Cuba, or Santiago de Cuba.
Mr. J. C. Landreau, United States consul	Cuba, or Santiago de Cuba.
Dr. Lucas Gallerdo	Gibara.
Rev. Francisco Clerch	Guanabacoa.
Dr. A. G. Del Valle	Guanabacoa.
Dr. A. W. Reyes	Guanabacoa.
Mr. W. F. Alison	Guantanamo.
Dr. Joaquin Boote	Guantanamo.
Board of health	Güines.
Board of health	Manzanillo.
Dr. J. A. Beltran	Marianao.
Dr. J. R. De Armona	Marianao.
Dr. José Forns	Marianao.
Dr. Enrique Morado	Marianao.
Board of health	Matanzas.
Dr. E. A. Calves	Matanzas.
Mr. George L. Washington, United States vice-consul	Matanzas.
Board of health	Nuevitas.
Mr. J. Sanchez, United States consular agent	Nuevitas.
Board of health	Pinar del Rio.
Board of health	Remedios.
Dr. P. De Elizalde	Remedios.
Dr. N. De la Peña	Sagua la Grande.
Board of health	Sagua la Grande.
Mr. J. F. Swords, United States consular agent	Sagua la Grande.
Board of health	San Antonio.

Dr. Cuervo A	Sancti Spiritus.
Dr. Bofill	San José de Las Lajas.
Dr. Cabrera	San José de Las Lajas.
Dr. Esteban de Navea	San José de Las Lajas.
Board of health	Santiago de Las Vegas.
Board of health	Trinidad.
Mr. G. Fischer, United States consular agent	Trinidad.
Mr. S. R. Ballesta, United States consular agent	Zaza.

Attention is called elsewhere in this report to the special services rendered by m of those above named. But there were some who rendered such zealous service conferred such important obligations that it would be ungrateful to omit soliciti thereto the special attention of the National Board of Health. The consul-gene Mr. Hall, and Dr. Burgess were indefatigable in intelligent efforts to serve their coun by every possible aid to the commission. Mr. Taylor, also a citizen of the Unit States, conferred invaluable services, not even hesitating to tax heavily his own p vate purse. Dr. A. G. Del Valle, the most eminent medical statistician in Cuba, co ferred numerous favors, and contributed to this report the most reliable statistics contains. Drs. Caneda, Pardiñas, Rodriguez, and Finlay, of the Spanish commissi bestowed favors which it is feared can never be repaid. Dr. Rodriguez, an alderm of Havana, presented to the United States, through the commission, and in behalf the city council, a magnificent map of Cuba, in thirty-six parts, and costing so $100. The Academy of Sciences, which honored the chairman and secretary of t commission by appointing them honorary members, also presented to the United Stat the seventeen volumes of its valuable transactions. The editors of the Crónica Médic Quirúrgica and of the Gaceta Médica also presented all of their published volume Col. Rafael Ceréro of the Spanish army, and Father Viñes of the meteorological o servatory of the College of Belen, extended many kindly courtesies and contribute very valuable printed documents. Drs. E. A. Calves, R. Mazarredo, and A. W. Rey rendered very important services, and deserve from the National Board of Health th highest consideration. The Messrs. Washington and Dr. Cross, in the consular ser ice of the United States, manifested great interest in the objects of the commissio and gave to it every possible assistance. It is feared that some names, which equall deserve mention, have been unintentionally omitted. Any such fault should be attrib uted to the difficulty of doing justice to all, when the number is so great.

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CHAPTER I.

CUBA AND ITS PORTS OF ENTRY.

Cuba, the largest of the more than one thousand islands of the West Indies, is situated less than 100 miles from the most southern islands of Florida. The Tropic of Cancer lies between them. Cuba is inclosed between the parallels of north latitude, 19° 50′ and 23° 10′, and between the parallels of longitude west of Greenwich, 74° 7′ and 84° 57′. Hence, on a parallel of longitude, the distance between the most northern and the most southern part of the island is about 230 miles, and the length of the island, on a parallel of latitude, is about 690 miles. However, this island is so irregularly curved in the sea, with the convexity to the north, that its average breadth is only about 52 miles, the extremes being from 20 to 135 miles, and its greatest length from east to west is nearly 800 miles. Few places of importance are more than 25 miles, none more than 50 miles from the sea-shore. Together with its small adjacent and dependent islands, Cuba is said to contain 47,278 square miles, and is therefore a little larger than the State of New York.* Once divided into a western and an eastern department, and subsequently into a western, central, and eastern department, it was in 1878 repartitioned into six provinces. These, from west

* The various figures given above can be accepted as approximations to absolute accuracy, sufficient for the purposes of this report. Among a half dozen or more authorities, it would be difficult to find any two of them who record exactly the same figures.

to east, are the provinces of Pinar del Rio, Habana, Matanzas, Santa Clara, Pu Principe, and Cuba or Santiago de Cuba. This report contains information in re to the important places in each one of these six provinces.

Cuba's extensive coast-line of about 2,200 miles, although in great measure inac sible because of shoals and reefs, has more than 200 harbors. Of these there are, on northern coast, eleven rated as of the "first class," and twenty-two of the "sec class," and on the southern coast five of the first and six of the second class. Howe Cuba has only fifteen "ports of entry" from which shipments are made to fore countries, and hence only these fifteen ports are of any interest in connection with infection of vessels. Eight of these are on the northern and seven on the south coast.

The eight northern ports of entry, passing from west to east, are Havana, Matan Cardenas, Sagua la Grande or Sagua, Caibarien, Nuevitas, Gibara or Jibara, and Ba coa, which last was the first settlement, 1512, made in Cuba, and is the principal p of the fruit trade. The seven southern ports of entry, passing from east to west, Guantanamo, Cuba or Santiago de Cuba, Manzanillo, Santa Cruz, Zaza or Tunas Zaza, Trinidad, and Cienfuegos.

The following table illustrates the comparative importance of the fifteen ports entry. It requires the following explanations: Since nearly one-third of the co merce between Cuba and the United States is carried on by foreign vessels, and sin the table refers solely to vessels of the United States, only about two-thirds of the tot trade is represented. Further, only eleven of the fifteen ports are accurate reported, because the necessary official information was not procured from the fo insignificant ports of Guantanamo, Gibara, Zaza, and Santa Cruz. It was reporte as to the last, that not one American vessel had either entered or cleared from i during the past year:

TABLE No. 1.—*Statement of the number of American vessels, their average tonnage, and th number of their crews, clearing from the ports of Cuba, for ports in the United States, dur ing the year ending December* 31, 1878.

[The data for the last four ports are the probable, but not the officially reported number. This table, as also Nos. 2 and 3, have been compiled from reports kindly furnished by the United States consul-general.]

Ports of entry.	Number of vessels.	Average tonnage of the vessels.	Total number of the crews.
1. Havana	503	653.8	10,505
2. Matanzas	313	399.5	2,615
3. Cardenas	291	334.9	2,358
4. Cienfuegos	152	427.3	1,581
5. Sagua	146	341.4	973
6. Baracoa	130	118.7	832
7. Caibarien	60	366.9	514
8. Trinidad	28	341.5	221
9. Cuba	22	488.9	177
10. Manzanillo	9	278.4	56
11. Nuevitas	3	327.8	21
Total	1,657		19,853
12. Guantanamo, about	30		200
13. Gibara, about	8		50
14. Zaza, about	5		30
15. Santa Cruz, about	0		0
Sum totals	1,700		20,133

An official report for the year ending June 30, 1878, stated that the number of foreign vessels sailing from Cuba to the United States was 744, of which 367 were Spanish, 288 were British, and the remaining 89 belonged to ten other nations. It thus appears that about 2,500 vessels and 30,000 sailors annually sail from Cuba to the United States, and that not less than 13 nations are pecuniarily interested in this traffic.

Since, so far as yellow fever is concerned, Havana is the most dangerously infectious port in the world, the following facts are of interest: the average number of vessels which annually entered the port of Havana during the ten years 1870–'79 was 1,850;* of these 817 were American, 645 Spanish, 223 British, and the remaining 165, be-

* In addition to these, there are, of course, many small vessels engaged in the coast or domestic trade. It is also to be noted that in recent years vessels to Havana have increased in tonnage rather than in number.

longed to various other nations. Although about 800 American vessels enter annually, yet so large a number of these clear for foreign ports, that the number which clear directly for the United States is correctly represented in the above table, as about 500 only. But, in addition to these 500 American vessels with their 10,000 sailors, passing annually from Havana to the United States, the number of foreign vessels and crews probably suffice to make a sum total of 700 vessels, and 14,000 sailors who every year enter the United States from this constantly infected port. Even these figures fail to represent the entire danger, for it appears that the average annual number of passengers (including those "in transit"), with their baggage, has been 4,755 during the ten years, 1870–'79.

Although preceding facts sufficiently reply not only to the question, "what are the princpal ports of Cuba?" but also to the question "what is the relative importance of these ports, and the amount of their commercial intercourse with the United States?" yet, it has been deemed essential, in connection with present or future quarantine and other sanitary regulations, to investigate three other subordinate questions. These are: A. What is the amount of intercourse between each port of the United States and all Cuban ports, as also between each American and each Cuban port? B. During what seasons of the year is this intercourse greatest and least? C. What is the value of this intercourse to the United States?

A. What is the amount of intercourse between the ports of the United States and the ports of Cuba?

This question is answered in the two following tables. Of these, table No. 2 is compiled from data furnished by the United States Bureau of Statistics, and table No. 3 from data furnished by the United States consul-general at Havana, Mr. H. C. Hall.

TABLE No. 2.—*Statement of the total number of vessels, American and foreign, which entered each of the various 27 ports of the United States from all the ports of Cuba during the year ending June 30, 1878, and the year ending June 30, 1879.*

Ports of the United States.	1878.			1879.			
	American.	Foreign.	Total.	American.	Foreign.	Total.	Average tonnage.
1. New York	701	209	910	823	283	1,106	514
2. Key West, Fla	234	31	265	294	20	314	181
3. Philadelphia	167	27	194	293	67	360	350
4. Boston and Charlestown	113	52	165	240	76	316	356
5. New Orleans	28	100	128	37	46	83	621
6. Baltimore	65	51	116	56	52	108	730
7. Pensacola, Fla	40	52	92	27	24	51	365
8. Charleston	13	63	76	8	54	62	391
9. Savannah	7	48	55	2	42	44	460
10. Pearl River, Miss	28	17	45	21	6	27	173
11. Mobile	17	17	34	11	5	16	263
12. Saluria, Tex	81	0	81	83	0	83	1,063
13. Wilmington, N. C	2	22	24	3	10	13	303
14. Brunswick, Ga	7	13	20	1	4	5	349
15. Saint Mary's, Ga	0	16	16	0	5	5	260
16. Fernandina, Fla	4	10	14	2	1	3	294
17. Portland and Falmouth	9	4	13	16	10	26	256
18. Galveston, Tex	3	9	12	5	7	12	511
19. Têche, La	10	0	10	5	0	5	1,046
20. Apalachicola, Fla	4	1	5	0	2	2	501
21. Saint Mark's, Fla	4	0	4	1	0	1	228
22. Saint John's, Fla	2	1	3	0	0	0	....
23. Brazos, Tex	1	0	1	2	0	2	177
24. Beaufort, S. C	1	0	1	0	1	1	388
25. Norfolk and Portsmouth	0	1	1	0	2	2	1,194
26. Stonington, Conn	1	0	1	0	0	0	....
27. Bangor, Me	0	0	0	1	0	1	179
Totals	1,492	744	2,236	1,881	717	2,598	....

This table demonstrates, among other facts of interest, that of all vessels sailing from Cuba to the United States more than two-fifths of them enter the port of New York, that less than two-fifths enter the five succeeding ports, and that less than one-fifth enter the eighteen southern ports (New Orleans included) south of Norfolk, Va. Excluding New Orleans, there are only 300 to 400 vessels from Cuba which enter annually all the other ports considered specially liable to yellow fever because of their geographical position.

Although Spain, the mother country, imposes from May 1 to October 1 severe quarantine restrictions on vessels from all Cuban ports, whether with or without clean

bills of health (see chap. XX), yet these ports are not all equally prone to infect shipping in their harbors; and vessels which do become infected are not dange in equal degree to all the ports of the United States. Hence it is of consequen determine the comparative amount of intercourse from each Cuban port to each in the United States. The desired facts as to foreign as well as to American ve were not procured; but the following data as to American vessels alone, and for year ending December 31, instead of June 30, 1878, as in table No. 2, furnish facts ficient for a satisfactory estimate. Since the data are derived from the same sou which supplied the materials of table No. 1, they are defective to the same slight tent, and for the same reasons, which were stated when introducing said table.

TABLE No. 3.—*Total number American vessels cleared from all and from each of ele Cuban ports for United States during year ending December 31, 1878.*

Ports of the United States entered in 1878 by vessels cleared from ten specified Cuban ports.	Havana.	Matanzas.	Cardenas.	Sagua.	Cienfuegos.	Baracoa.	Caibarien.	Trinidad.	Cuba.	Manzanillo.	Nuevitas.	Totals from
New York	160	166	144	77	57	114	40	1	7	8	1	[illegible]
Philadelphia and Delaware Breakwater	11	56	71	35	29	......	10	18	3	......	2	[illegible]
Key West and Cedar Keys	179	3	29	11	1	......	3	......	......	......	......	[illegible]
Boston and Charlestown	7	46	4	7	53	5	1	9	1	1	......	[illegible]
New Orleans and Southwest Pass	60	9	1	2	6	......	3	......	......	......	......	[illegible]
Baltimore	5	24	30	7	......	......	1	......	......	......	......	[illegible]
Indianola	31	......	......	......	......	......	......	......	......	......	......	[illegible]
Pensacola	14	4	8	1	2	......	......	......	1	......	......	[illegible]
Savannah	8	......	1	......	......	......	......	......	7	......	......	[illegible]
Pascagoula	10	......	......	1	2	......	2	......	......	......	......	[illegible]
Mobile	4	3	......	1	......	......	......	......	......	......	......	[illegible]
Charleston	......	......	1	......	1	8	......	......	......	......	......	[illegible]
Portland and Falmouth	1	......	2	2	......	......	......	......	......	......	......	[illegible]
North Hatteras	......	......	......	......	......	......	......	......	......	......	......	[illegible]
Morgan City	5	......	......	......	......	3	......	......	2	......	......	[illegible]
Pearl River, Shieldsborough, Handsborough	1	2	......	......	......	......	......	......	......	......	......	3
Brunswick, Ga	2	......	......	......	......	......	......	......	......	......	......	2
Galveston	2	......	......	......	......	......	......	......	......	......	......	2
Apalachicola	......	......	......	2	......	......	......	......	......	......	......	2
Jacksonville	......	......	......	......	1	......	......	......	......	......	......	1
Fernandina	1	......	......	......	......	......	......	......	......	......	......	1
Cat Island	1	......	......	......	......	......	......	......	......	......	......	1
Brazos	1	......	......	......	......	......	......	......	......	......	......	1
United States for orders	......	......	......	......	......	......	......	......	1	......	......	1
Totals	503	313	291	146	152	130	60	28	22	9	3	1,657

While this table correctly represents the *comparative* intercourse from the specified Cuban ports to the ports of the United States, it must not be forgotten that it inadequately represents the *absolute amount* of said intercourse, because it fails not only to report about forty vessels which sail annually from four omitted ports, but also to report the seven hundred to eight hundred *foreign* vessels which also sail to the United States. In another particular, still more important, the table is calculated to mislead in any estimate of the number of dangerous risks incurred by the United States from any one of these ports when infected; for a number of vessels sail from each of the chief and most dangerous ports coastwise, and are reported in the table as sailing from their last port of departure, perhaps an uninfected one, without reference to the fact that they had previously been at a dangerously infected port. Some idea of the number of such risks may be derived from the following facts: From that most dangerous port, Havana, there sailed in 1878, *directly* to the United States, five hundred and three American vessels, as is correctly stated in the table, but in addition to this number there were one hundred and seventy-six other vessels which sailed, coastwise from Havana; that is, to some other Cuban port. And these one hundred and seventy-six vessels are reported as cleared from their final port of departure, and not from Havana.

Medical records are full of instances where vessels, sailing from some other Cuban port, had become infected really at Havana. During the year 1879 two vessels at Matanzas were reported to have become infected at Havana, and one vessel entering Philadelphia from Sagua is reported to have become infected at Matanzas.

B. During what seasons of the year is the intercourse from Cuban ports to the United States greatest and least?

Of the 1,648 American vessels which sailed from the eleven ports of Cuba during the year ending December 31, 1878, the number which sailed during each of the four quarters of the year was as follows:

TABLE No. 4.

Cuban ports.	Total number of vessels during year.	Number of vessels first quarter.	Second quarter.	Third quarter.	Fourth quarter.
1. Havana	503	109	133	133	128
2. Mantanzas	313	67	148	68	30
3. Cardenas	291	55	144	69	23
4. Sagua	146	14	55	51	26
5. Cienfuegos	152	34	58	42	18
6. Baracoa	130	23	77	16	14
7. Caibarien	60	6	23	15	16
8. Trinidad	28	8	10	7	3
9. Cuba	22	12	3	3	4
10. Manzanillo	9	2	3	1	3
11. Nuevitas	3	1	1	....	1
Totals	1,657	330	655	405	266

During the year 1877 the corresponding figures were as follows: Of 1,460 American vessels, 415 sailed during the first quarter, 550 during the second quarter, 265 during the third, and 230 during the fourth quarter. It thus appears that a larger number of vessels sail from Cuba to the United States during the six months, April to October, than during the six months from October to April. It deserves notice that the largest amount of intercourse with Cuba occurs during the second quarter of the year, but that positive information was received that this excess occurred more especially during the months of April and May, and not usually in June. Since the four months, June, July, August, and September, are especially to be feared, and since it is during this period that the greatest conflict occurs between sanitary and commercial interests, it was deemed important to determine what proportion of our trade was carried on during these months. It is regretted that the desired data were not obtained except for the ports of Matanzas and Cardenas, but no reason is known why the facts as to these two should not correctly indicate the facts as to the other ports. The facts as to Matanzas and Cardenas are as follows:

TABLE No. 5.—*Statement, for five years, of the number of vessels of all nationalities which cleared annually for the United States from the ports of Matanzas and Cardenas during the four months, June to September, and during the whole year.*

Ports.	1874.		1875.		1876.		1877.		1878.		Totals for five years.	
	For the four months.	For the twelve months.	For the four months.	For the twelve months.	For the four months.	For the twelve months.	For the four months.	For the twelve months.	For the four months.	For the twelve months.	For the four months of the five years.	For the five years.
Mantanzas	100	529	136	514	61	418	78	357	145	425	520	2,243
Cardenas	58	405	89	445	59	394	79	297	126	350	411	1,791
Totals	158	934	225	959	120	812	157	654	271	775	931	4,034

Thus it is seen that considerably less than one-fourth of all the vessels which sail to the United States from Matanzas and Cardenas habitually sail during the four months, June to September.

C. What is the value to the United States of the intercourse with the ports of Cuba?

The day may come when the people of the United States will demand whether their

welfare would not be best promoted by suspension of intercourse with Cuba du certain months of the year; the day has come when this intercourse is much restrict and the day is always at hand when an intelligent people should be instructe what extent their pecuniary as well as their sanitary progress is involved in ev legislative measure. Commercial interests are so much prized, sanitary interests ill-appreciated, that vague and absurdly exaggerated statements of the value of Cuban trade find credence.

In January, 1879, an intelligent but interested witness testified before a commit of distinguished Congressmen and of medical experts engaged in the investigatio the yellow-fever epidemic of 1878, that the sanitary restrictions on the trade of N Orleans with the West Indies had during this one year injured that city to the ext of about one hundred millions of dollars. It is instructive that this evidence pas unquestioned in spite of the fact that the total annual exports of Cuba *to all nati* has rarely, if ever, exceeded that sum. The total exports of Cuba in 1878 were on $70,881,552, and of this sum there were $56,695,278 of saccharine products, a $13,213,690 of tobacco.

The following table teaches what very large proportion of the products of Cuba purchased by the United States, what very small proportion of American products sold to Cuba, what cities and towns are specially interested in these purchases a sales, and to what extent they are thus interested:

TABLE No. 6.—*Value of the imports from and of the exports to Cuba for the two fiscal yea ending June 30, 1878 and 1879, compiled from the data of the United States Bureau Statistics.*

Places in the United States trading with Cuba.	1878. Imports.	1878. Domestic exports.	1878. Total imports and exports.	1879. Imports.	1879. Domestic exports.	1879. Total imports and exports.
1. New York	$44,530,355	$7,469,977	$52,000,332	$44,895,007	$7,772,776	$52,667,783
2. Philadelphia	4,915,311	1,065,893	5,981,204	7,795,664	984,729	8,780,393
3. Boston and Charlestown	4,559,228	178,187	4,737,415	8,603,618	175,577	8,779,195
4. New Orleans	2,043,697	188,813	2,232,510	1,035,872	383,681	1,422,553
5. Baltimore	1,917,597	135,754	2,053,351	951,400	216,963	1,168,363
6. Key West	664,292	626,624	1,290,916	521,977	929,688	1,451,665
7. Portland and Falmouth	209,038	767,077	976,115	357,071	890,791	1,247,862
8. Saluria, Tex		379,951	379,951		369,533	369,533
9. Pensacola, Fla	2,320	109,149	111,469	52	140,294	140,346
10. Pearl River, Miss	95	68,572	68,672	320	55,232	55,552
11. Mobile, Ala	107	59,623	59,730	900	39,248	40,148
12. Perth Amboy, N. J		56,975	56,975		101,595	101,595
13. Galveston, Tex	622	53,400	54,022		48,275	48,275
14. Savannah, Ga	7,277	40,205	47,482	1,136		1,136
15. Richmond, Va		29,130	29,130		41,550	41,550
16. New Haven, Conn		25,000	25,000		37,595	37,595
17. Wilmington, N. C	6,295	20,880	27,175	21,270	1,081	22,351
18. Charleston, S. C	22,103		22,103	8,810	351	9,161
19. Brunswick, Ga	68	21,867	21,935	42	7,639	7,681
20. Saint Mark's, Fla	2,906	13,405	16,311	3,831	5,700	9,531
21. Machias, Me		13,107	13,107		19,107	19,107
22. Fernandina, Fla		10,179	10,179		8,684	8,684
23. Brazos, Tex	3,326	6,730	10,056	4,661	4,619	9,280
24. Georgetown, D. C		7,248	7,248		1,800	1,800
25. Apalachicola, Fla		5,458	5,458		3,539	3,539
26. Saint Mary's, Ga	25	4,584	4,609		2,440	2,440
27. Passamaquoddy, Me		3,312	3,312		8,738	8,738
28. Saint John's, Fla		2,019	2,019			
29. Wiscasset, Me		751	751		17,793	17,793
30. Waldoborough, Me		600	600			
31. New London, Conn		113	113			
32. Alexandria, Va					12,110	12,110
33. Bangor, Me				810	6,835	7,645
34. Newburyport, Mass					4,129	4,129
35. Belfast, Me					3,237	3,237
Total merchandise and specie	58,885,162	11,365,013		64,202,441	12,294,329	
Total specie	1,983,830			552,785	92,638	
Total merchandise	56,901,332	11,365,013	68,266,345	63,649,656	12,201,691	75,851,347
Total foreign exports		624,250			529,364	
Total domestic and foreign exports		11,989,263			12,731,055	

When it is remembered, that the epidemic of yellow fever in 1878 has been estimated to have inflicted on three Southern States some $100,000,000, and that statements are credited by many to the effect that quarantine restrictions, during only a few months of the year, inflict enormous loss on the commercial interests of certain places, it becomes a very notable fact that the total value of all exports and imports exchanged between all Cuban ports on the one hand, and all of the seventeen places in the above list, south of Richmond, Va., on the other hand, was only $4,369,237 in 1878, and $3,728,875 in 1879.

The above table illustrates the fact, proved by similar statistics for preceding years, that the total value of all products annually purchased from and sold to Cuba is less than $80,000,000. Of course, the profits derived from the interchange of commodities are likely to be very much less than the total value of said commodities, and any loss inflicted by restrictions on this interchange is a loss of part of the profits derived from the interchange, and not a loss of the commodities.

So many intricate problems enter into the calculation of the profits derived from commerce that even commercial experts would find it difficult to estimate the value to this country of its trade with Cuba, and still more difficult to estimate the much smaller profits which would be lost to the United States, by a suspension of or by restrictions on this trade during a few months of each year.

None the less, the facts given seem to justify the following conclusions: The United States is an indispensable market to Cuba; suspension of intercourse during a few months would tend to force the Cuban trade into the remaining months of the year rather than to seriously diminish this trade; the chief injury to the interests of the United States would fall upon the shipping and sailors temporarily deprived of occupation; and, finally, present sanitary restrictions on this trade certainly do not cause to the United States the great pecuniary loss which the people are incessantly taught is thereby inflicted.

CHAPTER II.

"THE ACTUAL SANITARY CONDITION OF THE PRINCIPAL PORTS IN CUBA."

The actual sanitary condition of every place is best tested by its annual death rate, which necessitates for its calculation the number of the population and the number of the deaths which occur every year in this population. In Cuba it is unusually difficult to procure these data. The last trustworthy official census published was for the year 1862 (sometimes designated the census of 1861, also of 1863), and a copy of this was procured with considerable difficulty, and not until a short time before the commission's departure from Havana. The more recent census of 1877 has not yet been published, and much delay and difficulty were encountered in obtaining from official sources a few insufficient, and, at times, discrepant data in manuscript from this census. So much care is required in handling these data of population that errors are constantly committed by nearly all who treat the subject. Two frequent sources of error will be alluded to. One is due to such a fact as that there is a *district* of Matanzas, in the *city* of Matanzas, in the *municipality* of Matanzas, in the *jurisdiction* of Matanzas, in the *province* of Matanzas, and some who state the population of *Matanzas* mean one of these political divisions, while others mean another, and there is frequent omission to designate which division is meant. Another error is due to the failure, often unavoidable, to keep the civil apart from the military population.

Still greater difficulties are encountered in determining the number of deaths which exactly correspond to any given population. The statistician is perplexed, not only by the confused mode of reporting dead civilians and soldiers variably intermingled, but also by the prevailing Cuban custom of reporting deaths by church parishes, which do not correspond with the political divisions in the census of the population. This Cuban habit of thus living politically and dying religiously is most vexatious to the statistician, if not to the moralist; and when considered in connection with other confusing perplexities, all recorded in the Spanish language, some idea may be formed of the care and labor required of one not conversant with this language to avoid being led astray.

The following death rates, all of which, as specified in this report, cite the number of deaths in *every thousand* of the population, have been compiled with great care from official reports. The sources of these, and the data from which the estimates are made, are detailed at sufficient length in the subsequent special reports of each place. To these the reader, who may desire further information, is referred. The death rates are for the *civil* population alone, and the data as to whites include Asiatics or Chinese, since Cuban statistics seldom permit the separation of these two races. Chinese coolies were first introduced in 1847; none have been introduced since 1874, and the total number in 1877 was 47,126.

The official instructions called for the sanitary condition of "the principal ports" of Cuba, and in the following table the death rates are specified for twelve of the fifteen total ports of entry. But further light was thrown on the subject by including in the table the death rates of seven of the chief inland towns, and of the whole island of Cuba. Dr. Melero (p. 294, v. 15, 1878, Anales) estimates the death rates of the island of Cuba, for the three years of the most reliable published censuses, as follows: 26 per 1,000 population in 1827, 24 in 1846, and 32 in 1862. Dr. Chas. Finlay (p. 267 *ibid*) estimates the death rate of the same for 1862 as 24.2. With these estimates my own derived from the data published in the censuses, and also in a subsequent chapter of this report, do not, as will be seen, precisely coincide.

Where several years are united, for instance, 1861-2-3, it is thus indicated that the corresponding death rates are for the annual average deaths of these three years whereby a better approximation to the habitual death rate is obtained.

TABLE No. 7.—*Death rates of Cuba, of twelve principal ports of Cuba, and of seven inland towns.*

Places.	Population.		Death rates.			
	Years of census.	Total population.	Years.	White and Chinese.	Colored.	Total.
Island of Cuba	1827	704, 487	1827	21. 3	25. 5	23. 6
	1846	898, 754	1846	25. 6	20. 8	23. 1
	1862	1, 396, 470	1862	22. 1	25. 6	23. 6
PRINCIPAL PORTS.						
Havana	1862	190, 315	1861-2-3	....	....	36. 3
	1877	195, 437	1876-7-8	36. 7	48. 2	39. 5
Regla*	1877	11, 031	1878	46. 5	65. 9	50. 1
	....	....	1879	37. 7	61. 0	42. 1
Matanzas	1862	30, 539	1861-2-3	44. 6	45. 7	45. 0
	1877	37, 147	1876-7-8	40. 9	56. 1	44. 5
Cardenas	1862	10, 885	1861-2-3	51. 1	73. 4	58. 4
	1877	17, 784	1876-7-8	35. 1	52. 1	39. 5
Cienfuegos	1862	9, 950	1861-2-3	52. 6	61. 0	55. 9
	1877	20, 318	1876-7-8	75. 0	52. 0	66. 7
Sagua	1862	9, 632	1861-2-3	25. 5	26. 1	25. 7
	1877	18, 553	1876-7-8	53. 6	42. 0	50. 0
Baracoa	1877	5, 095	1877-8	36. 6	53. 7	43. 5
Caibarien	1877	5, 670	1878	28. 5	34. 5	29. 4
Trinidad	1877	17, 990	1876-7-8	28. 7	35. 5	31. 9
Cuba	1877	40, 835	1877-8	....	....	34. 5
Manzanillo	1877	13, 480	1876-7-8	34. 9	47. 1	40. 0
Nuevitas	1877	4, 466	1878	30. 9	47. 9	33. 1
Guantanamo	1877	8, 386	1877-8	53. 2	70. 2	63. 0
INLAND TOWNS.						
Bejucal	1877	7, 008	1878	23. 5	33. 7	25. 7
Guanabacoa	1877	20, 501	1874-9	35. 5	49. 0	39. 8
Marianao	1877	6, 863	1877-8	....	....	39. 5
Remedios	1877	12, 452	An'ally.	....	....	"40 to 50"
Sancti Spiritus	1877	24, 428	1876-7-8	35. 8	44. 2	37. 5
San José de las Lajas	1877	6, 029	1877-8	27. 8	40. 7	31. 0
Santiago de las Vegas	1877	10, 831	1876-7-8	21. 0	31. 0	28. 5

*Regla is sanitarily though not politically, a part of Havana.

The above table, compiled from data furnished by Cuban officials, teaches a number of interesting facts. It clearly proves that "the actual sanitary condition of the principal ports of Cuba" is very unfavorable, since, in recent years, their death-rates have ranged from 31.9 to 66.7. It also proves that the sanitary condition of the inland towns is very little, if at all, better than that of the sea-ports. The high death-rates of Guanabacoa, and of Marianao are especially notable, because these suburban towns, within three and six miles of Havana, are summer resorts, and enjoy, especially Marianao, a high repute for salubrity. Taking a general view of the death-rates for the total population of all the twenty towns in the above list—towns selected, solely because the only ones which furnished reliable official reports, though many others were solicited, it will be found that twenty-six death-rates are given; that these range from 23.5 to 66.7, and that, while only eight of the 26 are under 35, twelve of them are 50 or more. These facts, together with the well-known difficulty of procuring full re-

ports of all deaths in any country, especially among its rural population, impair greatly one's confidence in the death-rates given in the table for the whole island of Cuba; this probably exceeds the estimated 23.6. It deserves special attention that the high death-rates in many Cuban cities and towns are not dependent on yellow fever mortality; for, in most of these, as in Regla, Guanabacoa, Marianao, &c., the number of unacclimated inhabitants is so few that if all the certified deaths by yellow fever were deducted from the total annual deaths there would be only a fractional reduction of their death-rates. That the high death-rates are independent of deaths by yellow fever is also conclusively proved by the excessive mortality of the negro race, or "colored." The table records twenty-five colored death-rates, and of these there are only three which are less than the corresponding death-rates for the whites. Other researches confirmed the lesson thus taught, viz, that in Cuba, as in the other Antilles and generally throughout America, the death-rate of the negro race is habitually higher than of the white race, and that exceptions to this rule are due to some such temporary cause as the occurrence of a severe epidemic of yellow fever.

The actual sanitary condition of any place can be also well illustrated by the relative proportion of births to deaths. Vital statisticians of Cuba and of the French Antilles have asserted that these islands, because of the preponderance of deaths over births, would become depopulated were it not for the constant accession of foreign immigrants. Though reports of births were solicited, none were obtained except for Cardeñas, Cienfuegos, Havana, Marianao, and Matanzas; and these data will be found recorded in the special report of each of these places. In all five of said places, Cardeñas excepted, the total annual deaths considerably exceeded the total annual births, and even in Cardeñas, where was reported a very slight excess of births, this excess occurred in the colored, but not in the white, births.

Preceding facts amply suffice to prove what is the actual sanitary condition not only of the principal ports, but also of the principal inland towns (Puerto Principe excepted*) of Cuba. But science demands more than bare proofs of the insanitary condition of a place, and, in addition to efforts to determine the causes thereof, much labor was expended in collecting facts to show what diseases chiefly contributed to the great mortality.

The statistics of deaths by diseases are unusually defective in Cuba. None could be obtained except for a few hospitals, and for the towns of Matanzas, Havana, Regla, and Guanabacoa. All of these are elsewhere published in all their details. The only statistical reports, reliable and answering the present purpose, are by Dr. A. G. Del Valle for Havana, Regla, and Guanabacoa. The following table records the fatality by the diseases which cause seven-tenths of all the annual deaths in these three places. To comprehend certain contrasts in the tables it is necessary to understand certain differences in the conditions of these towns. Havana has, and the other two have not, a large military and a large unacclimated population, and therefore a large excess of adults, especially males; Regla is much exposed to malaria; and Guanabacoa has the smallest unacclimated population, and being located on the summit of the hill, 130 to 160 feet high, is least exposed to malarial poison. The total annual deaths in Havana are about 10,000, in Regla about 500, and in Guanabacoa about 900.

TABLE No. 8.—*Diseases causing about seven-tenths of the annual deaths in Havana, Regla, and Guanabacoa.*

Diseases.	Havana.	Regla.	Guanabacoa.
1. Phthisis, about	1,700	100	225
2. Diarrhea, dysentery, and cholera infantum, about	1,500	33	105
3. Yellow fever, about	1,500	20	7
4. Other fevers, chiefly malarial, about	600	35	35
5. Small-pox, about	550	75	75
6. Trismus nascent., about	400	25	60
7. Meningitis, about	300	15	50
8. Pneumonia, about	300	17	45
9. Hepatic diseases, about	250	25	33
Total	7,100	345	635

This table probably represents correctly the relative fatality of the chief diseases throughout the island, and abounds in instructive suggestions, and in unsolved problems. The frightful mortality by phthisis is especially noteworthy. In every one of the past eight years, 1872-'79, the only years for which the dates are reported, the annual deaths in Havana by consumption has even exceeded the deaths by yellow fever;

* Unfortunately no reports could be obtained of this the largest inland town in Cuba.

and yet, though phthisis is so destructive to the residents of Havana and Cuba, these places are still visited by the afflicted from abroad. Throughout the Antilles, wherever mortality statistics have been collected, phthisis has always been found in the front rank. No fact better proves the prevalence of insanitary evils; for the dependence of phthisis on these, and especially when associated with subsoil moisture, has been well established. However, it deserves attention that the proportionate mortality by phthisis in the three places designated in the above table is greatest in Guanabacoa, which has the highest altitude, and presumably the least subsoil moisture.

Malarial poison probably inflicts more injury on health and life in Cuba than phthisis or yellow fever, or any other single cause. The number of reported deaths by malarial fevers always represents most inadequately the widespread and destructive influence of swamp poison, which, ever present, never inactive, inflicts far more injury by stealthily undermining and gradually destroying health than by sudden and fatal attacks. The extent of its influence is much better tested by the number of persons it attacks than by the number it directly kills. In one of the private infirmaries of Havana there was, in 1878, about one-third of nearly three thousand admissions due to this one poison alone. In Matanzas, Cardenas, and Cienfuegos there is even more swamp poison than in Havana. At every place visited the physicians testified that from one-third to three-fourths of all cases of sickness were due directly and solely to malarial poison, while it complicated almost every case of all other diseases. One physician of great experience and distinction asserted that nothing more was needed to practice medicine successfully and prosperously in Cuba than to administer quinine with discretion.

In view of the grossly insanitary conditions which favor the great prevalence of phthisis, of small-pox, of yellow and malarial fevers, it is remarkable that measles, scarlet fever, diphtheria, and typhoid fever should play such an insignificant role in the mortality records. During the nine years 1871–'79, the deaths in Havana, which fairly illustrate the other places, ranged as follows: measles, 0 to 28; scarlet fever, 1 to 6; diptheria, 23 to 61; and typhoid fever, as *certified* but probably not as actually occurred, from 144 to 211. Diptheria has occasionally prevailed severely; Dr. Mazzaredo of Cienfuegos testified most positively that it had never appeared in this place until after its appearance in Havana, and until after the establishment of frequent and rapid intercourse between these two places. If typhoid fever be a "filth disease," it is inexplicable why it does not commit infinitely greater destruction in Havana and throughout Cuba.

The proximity of sleeping apartments to stables causes farcy to be a not unfrequent disease in Cuba, and in Havana there are about ten lives annually sacrificed in this way. Leprosy prevails in Cuba, as in the other Antilles, showing a marked preference first for Asiatics, next for negroes, and last for white creoles, seldom attacking Europeans. Cuba has two, perhaps three hospitals for lepers; the hospital in Havana has about 100 leprous inmates, one-half of whom are Chinese. Beriberi, which is reported never to have been known in Cuba, until after the first arrival of Chinese in 1847, often proves very destructive on plantations to Chinese and negro laborers. Additional facts are reported, in a subsequent chapter, in respect to leprosy and beriberi.

CHAPTER III.

THE "SO-CALLED" ENDEMICITY OF YELLOW FEVER IN HAVANA AND CUBA.

Endemic and epidemic are words used by even the best writers in a vague and, at times, contradictory sense, so that, whoever would not be misunderstood is forced to explain the significance he proposes to attach to them. Endemic is derived from two Greek words, which signify "in" "a district" or a locality; and an endemic disease really means nothing more, according to its derivation and to the best authorities, than a disease which "belongs to a particular district," and to which, therefore, its "inhabitants are peculiarly subject." However, in times not very remote, such fables as the spontaneous generation of countless maggots localized in the carcass of a dead lion easily secured credence, and it would be difficult to mention any disease to which physicians have not concurred in assigning, in comparatively modern times, a spontaneous local origin. Hence, it occurred that the word endemic was formerly much abused by using it to designate a disease which was not only known to prevail habitually in some special locality, but was also *supposed* to originate there. Modern research has conclusively proved, not only that very many diseases, once supposed to have, did not have a local origin, any more than had man himself, the victim of these diseases; but also that the local causes, supposed to originate, were in reality nothing more than the causes which favored the propagation of these diseases. Hence, by the best modern authorities, the adjective endemic is used to designate a disease which habitually prevails in a given locality, without regard to its supposed origin, or to any other

theory. Accordingly, French and Spanish physicians in the West Indies have long been in the habit of designating yellow fever, as it occurs in some of the Antilles, as an "endemic" disease. This is so universal in Cuba that yellow fever is often referred to there as "the endemic," and this is done as freely by those who do not, as by those who do, advocate its local origin, for no other idea is intended to be conveyed than that yellow fever habitually prevails in the special locality which may be designated. Refusing to abuse the word by forcing it to bear the burthen of any theory, I shall use it to indicate "the prevalence in a locality" of a disease, and shall mean by this the habitual annual prevalence, even though this prevalence may not characterize every month in the year, and may occasionally disappear during an entire year. Used in this sense, the facts recorded in this report sufficiently indicate to what extent yellow fever is endemic or prevalent in Havana, and elsewhere in Cuba.*

The official instructions of the National Board of Health directed the commission "to obtain as much information as possible with regard to the so-called endemicity of yellow fever in Cuba." This required investigations to determine the length of time during which yellow fever had prevailed in Cuba, the places where it prevailed, and the extent of its prevalence in each place. On these topics much information, and all which it was possible to collect, was procured, and is recorded at length elsewhere in this report; hence, only a brief summary of these lengthy details will now be given.

HISTORY OF THE PREVALENCE OF YELLOW FEVER IN CUBA.

There was very certainly no habitual prevalence of yellow fever in Cuba until the year 1761, when it is alleged to have made its first appearance in Havana. To properly appreciate this fact, it is indispensable that it should be associated with some facts relative to the general history of yellow fever prior to this time; and such a history is divisible, conveniently for present purposes, into two periods, the first from the first European settlement in America, at San Domingo, in 1492, to about 1635, and the second from 1635 to 1762.

Those familiar with the history of general literature, and especially of medical science from 1492 to the present day, need not be reminded through what an abyss of illiteracy, quackery, and medical ignorance civilized nations have slowly progressed to the present day; and that only in recent times have there been ample means to publish, and any considerable number of medical men competent to observe and record what was worthy of publication. Hence, it is not surprising that, though the records of yellow fever are very abundant in modern times, these records become less and less satisfactory, until, as we pass backwards, an epoch is reached such as that from 1492 to 1635, of vague allusions to "pests," and inconclusive descriptions of any particular disease. This epoch might be termed the traditional era of yellow fever, and the period since 1635 the historical era.

1492 to 1635.—There is reason to suspect that the Spaniards in San Domingo suffered with yellow fever during the very first year, 1493, they passed on this island. It is more certain that they did suffer in 1494, the year which is usually given as the first when man was attacked by this disease. As a matter of fact, 1494 is simply the first year in respect to which we now have fairly credible published evidence of the first appearance of yellow fever among men who knew how to write and to print. This falls far short of proof that mankind never suffered with yellow fever until 1494; and, in truth, we have no more reason to credit this assigned first appearance than to credit similar failure of records respecting numerous other diseases. Vera Cruz now annually proves that American Indians are liable to yellow fever; every place where yellow fever habitually prevails proves that the inhabitants gain immunity from the disease; and Cuba now contains many intelligent citizens who will assert positively, notwithstanding that they have easy methods, which the first European settlers in San Domingo had not, to gain correct information, that this, that, and the other place has not and never had yellow fever, while the records of their own hospitals prove the contrary. It is neither singular nor exceptional that illiterate Spanish adventurers, ignorant of medicine, should have failed to recognize and record the presence of the poison of yellow fever among acclimated Indians, whom they regarded as heathen brutes, and whose language they could not understand. For such reasons, it is firmly believed that the poison of yellow fever did not have its first origin in 1493 or 1494, and that we are no more likely ever to discover this than to fix the date of the first origin of a dog or a cat.

The scanty and unsatisfactory records for the 144 years from 1493 to 1635 justify the belief that not less than nineteen yellow fever epidemics occurred in San Domingo, Porto Rico, and the Isthmus of Darien; and that sixteen of these afflicted San Domingo. In addition, one author vaguely states that yellow fever has probably prevailed at Vera Cruz ever since its foundation in 1519.

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* No serious objection is made to Liebermeister's definitions, that "an endemic is limited locally, and remains long or persistently; while an epidemic appears at intervals and again disappears."

1635 to 1762.—From 1635 the historical record of yellow fever becomes more and more authentic, and no doubt is entertained that the first European settlers of Guadaloupe in 1635 suffered severely. During the 128 years, 1635 to 1762, history records 208 invasions of yellow fever during 86 of these years in 43 different localities. Among these there were in the United States, from 1693, when Boston was invaded by yellow fever (its first positive appearance in this country), to 1762, not less than 44 epidemics in twelve different places. Thus it is certain that this dreaded disease had repeatedly scourged many places before it made Cuba one of its homes.

HISTORY OF YELLOW FEVER IN HAVANA AND CUBA, 1761-1880.

Cuba was first settled by the Spaniards, and at its eastern extremity, in 1511. The attractions of Mexico and Peru were so much greater than those of Cuba that this island long attracted very few European immigrants; how few may be judged by the following facts: Although the period of its great prosperity began in 1762, yet, even twelve years after this, in 1774, when its first census was taken, its white population was less than 100,000. And, it may here be mentioned, since a few writers have attributed the first appearance of yellow fever in some of the West Indies to the importation of African slaves, that in 1521 or 1523 "the first three hundred African slaves were brought from San Domingo to Cuba"; that during the succeeding 242 years only about 60,000 were imported, of whom there were about 32,000 living in 1763; and that in this and subsequent years the importation increased so enormously that in 1774 Cuba had a colored population of 75,180. The city of Santiago de Cuba, at the southeastern extremity of Cuba, was founded in 1514, was long the capital of Cuba, and although still its second city in population, it has even now only about 40,000 population. Havana, founded in 1515-1519, had in 1600 a population of only about 3,000, in 1700 about 9,000, and in 1792, after thirty years of unprecedented prosperity since 1762, only about 50,000.

The earliest records which justify any suspicion of yellow fever in Cuba are to the following effect: From 1648 to 1655 it is recorded that "a pest of putrid fevers," imported from the continent of America, and very destructive to soldiers and sailors, caused great consternation in Cuba, proving specially destructive in Havana and in Santiago de Cuba in 1649. The board of health of the latter place officially reported in 1879, "Some assert that yellow fever first appeared here in 1686, imported from Martinique, but the most reliable data state that the disease was not known here until 1745-'48." Whatever value may be attached to this evidence, the following deserves full credence: Though Spanish literature is unusually rich in valuable histories of Havana and Cuba, nothing has been found, after very careful search, justifying even a suspicion that yellow fever was known in Havana or elsewhere in Cuba, excepting the above quotation as to Santiago de Cuba, from 1655 to 1761. On the contrary, repeated references are made to the remarkable salubrity of Havana, and to the absence of all exceptional or devastating diseases. While such references cannot be accepted as absolute proof of the non-existence of the disease during all of these years, they do present strong evidence that it did not exist either habitually or severely. The year 1762 was a notable year to Cuba, since Havana was besieged, captured, and held for more than a year by an English military expedition of some 30,000 soldiers and sailors. In this year a yellow fever epidemic, alleged to have been imported, committed destructive ravages, and it is not singular that some historians should have committed the comparatively inconsequent error of stating that this was the first appearance of the disease. Ample historical evidence, which is elsewhere detailed, was secured, proving that the first well-authenticated epidemic, alleged to have been imported from Vera Cruz, occurred in 1761. Decisive and satisfactory evidence is also elsewhere presented, proving that yellow fever has prevailed every year from 1761 to the present time.* All medical authorities on this subject record the occurrence of this disease at Havana in certain specified years, and thus mislead the student into the false inference that it did not prevail during the unrecorded years. In truth, these recorded years simply indicate the years of greatest violence, while in every year since 1761, though unrecorded by the authorities, the poison was present, and the disease did prevail. This fact deserves the more serious consideration, because medical literature contains many reports of the outbreak of yellow fever on ships at sea after visiting Havana, associated with the statement that there was no yellow fever there when the ship was in the harbor. Such statements deserve no credence whatever, and therefore of course none should be given to the inference usually drawn therefrom, to the effect that the disease must have originated spontaneously and *de novo* on the ship. For more than a century the poison has been constantly present, even though there may have been brief intervals during which no unacclimated persons were exposed to it, or during which the poison was inactive.

*See chapter XVII, also chaps. XVIII and XIX, for other details referred to in the present chapter.

THE PLACES IN CUBA IN WHICH YELLOW FEVER IS PREVALENT AND THE EXTENT OF ITS PREVALENCE.

The following general statements deserve precedence over details. Residents, whether foreign born or natives, of the mountains and of other secluded rural portions of Cuba suffer with yellow fever on visiting infected places. This evidence, that they have not acquired immunity from the disease, proves that they have not been habitually subjected to the poison, and, therefore, that their places of residence are not the habitats of the poison. There are also large towns in Cuba which never suffered with yellow fever until quite recent times; for instance, the disease never visited Güines until 1834, nor Holguin, a town located in a sparsely inhabited district with bad roads and little commercial intercourse, until 1851, when the disease is said to have been imported by soldiers. These facts deserve the serious consideration of those who believe that climate can generate yellow fever, and of those who believe that while climate alone cannot, yet that this associated with the filth and other conditions which result from the aggregation of men in towns can generate it.* Wherever commercial intercourse and the number of European immigrants are greatest, there yellow fever most prevails, and these two factors, though not the only ones necessary to propagate yellow fever in Cuba, are the chief and all-important ones in the explanation of the different degrees of prevalence in different places.

Havana has five times the population of any other city in Cuba; its commercial intercourse and the number of its annually arriving unacclimated immigrants are proportionately even greater than this, and in this city the prevalence of yellow fever is greatest. The extent of this is illustrated by the following facts: The authorities of Cuba furnished the United States commission with monthly reports, in manuscript, of the number of cases and deaths occurring every month by yellow fever in the military and civil hospitals of Havana, and, let it be observed, not in the whole civil population. Beginning with January, 1856, as far back as there are reports for both the military and civil hospitals, it is found that during all of the 408 months to January, 1880, there was but one single month, viz, December, 1866, free from an *officially reported* case of yellow fever in the hospitals alone. Such a fact, as to the past twenty-four recorded years, fully justifies the belief that the same thing occurred during very many prior and unrecorded years. Owing to the voluntary labor of a noble private citizen, Dr. A. G. Del Valle, we have, during the past ten years and for the first time, reliable reports of all deaths in Havana, not only of those occurring within, but also without the hospitals. These reports furnish the data in the following table, which shows in one column the least and in the other the greatest number of deaths which have ever occurred in any month during the past ten years. It should be remembered that the number of deaths indicate at least treble that number of persons attacked.

TABLE No. 9.—*Monthly minimum and maximum deaths by yellow fever in Havana during the ten years* 1870–'79.

Months.	Minimum.	Maximum.	Months.	Minimum.	Maximum.
January	6	32	July	68	675
February	4	24	August	70	417
March	4	32	September	35	234
April	4	37	October	28	185
May	13	127	November	5	150
June	66	378	December	9	82

The total deaths during each of these years are given in the following table; the number of civilians were obtained by deducting from the totals the number of soldiers' deaths reported by the military hospitals.

* The following facts, among others to like effect, deserve the consideration of those who find in climate and filth adequate generators of yellow-fever poison: Several towns in Louisiana south of or in the same latitude with New Orleans have occasionally suffered with yellow fever, and always, so far as I can learn, certainly generally, these have been attacked *subsequently* to New Orleans. If climate and filth generate yellow fever, then it ought to occur *simultaneously* in these places with its appearance in New Orleans, or *even earlier* in those of these places which are farther south. Their commercial intercourse with New Orleans is constant, and it seems impossible to explain, except by importation of the poison, its appearance always subsequently even in places farther south.

TABLE No. 10.—*Annual deaths by yellow fever in Havana, in the civil, military, and total population, during the ten years 1870–'79.*

Years.	Civil population.	Military population.	Total population.
1870	277	388	665
1871	796	195	991
1872	372	143	515
1873	1,019	225	1,244
1874	1,236	189	1,425
1875	678	328	1,001
1876	900	719	1,619
1877	575	799	1,374
1878	818	746	1,559
1879	737	707	1,444
Totals	7,398	4,439	11,837

The very large proportion of deaths in the military population proves how erroneous is a belief that yellow fever is exceptionally and more especially severe in the shipping and harbor of Havana. This erroneous belief is due to the two facts that in infected harbors there is frequently a disproportionately large number of foreign seamen susceptible to the disease, and that foreign countries are more deeply impressed by the death of their own countrymen temporarily abroad than by the death of even a far greater number of the natives and residents of the infected place.

In the special reports of different places will be found all the evidence on which the following statements, in reference to the endemicity of yellow fever in various towns of Cuba are based. These statements are not satisfactory as to some of the smallest towns, because of ignorance of the number of their unacclimated population. The poison of yellow fever may be annually present in a place, and yet if there be no unacclimated inhabitants, there would be no cases of yellow fever to prove the presence of the poison. Failure to appreciate this difficulty subjects one to the danger of hastening to false conclusions on many questions which arise concerning the comparative prevalence of yellow fever in different parts of Cuba.

The extent of this prevalence will be briefly summarized in respect to, first, the 15 ports of entry; second, 6 seaports which are not ports of entry; and, third, 22 inland towns.

TABLE No. 11.—*Relative prevalence of yellow fever in 43 cities and towns in Cuba.*

PORTS OF ENTRY.

1. *Havana.*—Annual prevalence since 1761, the chief center of infection, and most dangerous to the shipping.

2. *Matanzas.*—Annual prevalence certainly since 1828, and probably much longer; an important center of infection, but less dangerous to shipping than Havana.

3. *Cardenas.*—Annual prevalence certainly since 1836, and it was not founded until 1828. It is an important center of infection, but not specially dangerous to shipping, because of the distance vessels anchor from the shore.

4. *Cienfuegos.*—Annual prevalence since at least 1839, and it was not founded until 1819–1825. It is a dangerous center of infection, but, like Matanzas, has a very large harbor, and is less dangerous than Havana to the shipping.

5. *Sagua.*—Some cases of yellow fever occur annually, but vessels are very rarely infected, as these anchor several miles distant from the coast, and Sagua is 10 miles inland.

6. *Baracoa.*—Yellow fever occurs occasionally as an epidemic, but not annually as an endemic.

7. *Caibarien.*—Cases of yellow fever occur frequently, but not every year. Very little dangerous to vessels, as these anchor many miles distant.

8. *Trinidad.*—Annual prevalence certainly since 1838, and probably longer. The harbor is not believed to be specially dangerous to vessels.

9. *Cuba.*—Annual prevalence certainly since 1851, and probably very much longer. It is a noted center of infection, and its small harbor is very dangerous to the shipping. This, next to Havana, is probably the most dangerous place to shipping in the whole island.

10. *Manzanillo.*—Annual prevalence. It is in constant communication with Cuba, Trinidad, and Cienfuegos. As vessels anchor in the open sea, several miles from shore, they probably suffer little.

11. *Nuevitas.*—Annual prevalence. Vessels anchor a mile or more distant, and are in little danger.

12. *Guantanamo.*—Annual prevalence. The town is about seven miles from the harbor, and vessels are probably little exposed to infection.

13. *Gibara.*—Cases of yellow fever do not occur every year. Vessels anchor distant from the shore, and are in little danger.

14. *Zaza.*—Cases of yellow fever do not occur every year. Vessels are probably in very little danger.

15. *Santa Cruz.*—Cases of yellow fever occur in the majority of, but not in all, years. Vessels anchor far from shore, and are in little danger.

SEAPORTS WHICH ARE NOT PORTS OF ENTRY.

16. *Bahia Honda.*—Yellow fever is not endemic, is even said to be "unknown," and to present no cases "either indigenous or imported."

17. *Batabano.*—Very few cases occur.

18. *Cabanas.*—Cases occur very rarely, and the disease is not endemic.

19. *Isle of Pines.*—Cases very seldom occur, and it is as remarkably free as is Bahia Honda from the disease.

20. *Mariel.*—Yellow fever is not endemic here.

21. *Puerto Padre.*—The disease is not endemic.

INLAND TOWNS.

22. *Bayamo.*—Occasionally epidemic, but not annually endemic.

23. *Bejucal* suffers little with yellow fever.

24. *Ciego de Avila.*—Not endemic.

25. *Cobre.*—Yellow fever is not endemic.

26. *Colon.*—Yellow fever is not endemic.

27. *Guanabacoa.*—Cases occur annually.

28. *Guanajay.*—Cases occur in the majority of years.

29. *Güines.*—Yellow fever is not endemic.

30. *Holguin.*—Several epidemics since 1851, but cases do not occur every year.

31. *Jaruco.*—Endemic.

32. *Marianao.*—Endemic.

33. *Mayari.*—Not endemic.

34. *Palma Soriano.*—Not endemic.

35. *Pinar del Rio.*—Not endemic.

36. *Puerto Principe.*—Endemic.

37. *Remedios.*—Endemic.

38. *San Antonio.*—Endemic.

39. *Sancti Spiritus.*—Endemic.

40. *San José de las Lajas.*—Endemic.

41. *Santa Clara.*—Cases occur in the majority of years.

42. *Santiago.*—Endemic.

43. *Victoria de las Tunas.*—Cases occur in the majority of years.

The above forty-three places are all those from which trustworthy information was secured, and it appears that of 21 seaports,* yellow fever occurs annually in 10 of them, and does not occur annually in the remaining 11; while of 22 inland towns, the disease occurs every year in 9 of them, and not every year in the remaining 13. A larger proportion of the seaports exceed the inland towns in the extent of their commerce with permanently infected centers, and in the number of immigrants, so that the above list tends very strongly to prove that seaports in Cuba are no more liable to yellow fever, solely because located on the sea, than are inland towns. Yet the contrary has long been taught.

CHAPTER IV.

CAUSES OF THE INSANITARY CONDITION OF HAVANA, AND OF THE SEAPORTS AND TOWNS OF CUBA.

Nature has afflicted Cuba with swamps adjacent to the localities appropriated by man; has provided these places with a meager or inconvenient water supply; has constructed the island for the most part of coral limestone or other porous, friable rocks, covered to only a slight depth with surface soil; and has located this fertile island, so tempting to man's greed of gain, in a climate which favors to the utmost decomposition, putrefaction, and the propagation of vegetable and animal life. Man

* In fact, Sagua and Guantanamo, though ports of entry, and always classed as seaports, are, the one 10 and the other 7 miles inland; hence, in the above comparison between seaports and inland towns there were really only 19 of the former with 24 of the latter, and the comparison between them is, in truth, more favorable to seaports and less favorable to inland towns than represented.

may hold nature directly responsible for any insanitary evils resulting from these conditions, which, however, if history be true, failed during centuries to generate yellow fever. But for insanitary conditions other than these man is forced to consider to what extent he himself is responsible. Mankind in Cuba is by no means exceptional in having not only neglected this responsibility, but also in having, from ignorance and avarice, even abetted nature in its warfare against him. Healthy life is impossible without an adequate supply of pure drinking water; but, above all other requisites, a superabundance of fresh, unpoisoned air is the most imperative, and to secure this prime necessity it is indispensable that there should be an ample water supply for cleansing purposes, that the soil should be kept well drained and unpolluted, and that the streets, houses, and harbors or other surroundings should all accord with the laws of hygiene. What has been done and been left undone in Cuba to secure these requisites to healthy life? The following facts, though they refer especially to Havana, will serve to illustrate existing conditions in Cuban towns generally, while details as to these will be found in the subsequent special report of each place.

A.—WATER SUPPLY.

Until about 1591, the water supply of Havana was derived from wells, and from such streams as the Luyano and the Almendares, which are several miles distant from the old intramural city. The so-called river Almendares, the larger of these two small streams, empties into the sea less than four miles west of the entrance to the harbor of Havana; it is fed chiefly by springs, and the water is reported by experts to be good. In 1566 a water-course, or really a ditch, which is designated the Zanja, was begun for the purpose of furnishing a better supply of water by connecting the city with the Almendares River, at a point called Huxillo, about five miles distant. The Zanja was not completed and extended into all parts of the city until 1591–'97. Pezuela states that its capacity is 70,000 cubic meters daily, but that, because of leakage and its application to the irrigation of intervening places, only 20,000 cubic meters reach the city. Throughout the most of its course the Zanja flows through unprotected mud banks, the fluids of many houses, especially in the Cerro ward which it skirts, drain into it; men, horses, and dogs bathe in it; dead bodies have been seen floating in it, and in the rainy season the water becomes very muddy; in fine, the Zanja in its course receives all which a little brook traversing a village, and having houses and back yards on its banks, would receive. The water cannot be pure, and to those who know the facts the idea of drinking it is repulsive. This supply had long been insufficient to the growing city, and, in 1835 the well-protected and excellent aqueduct of Ferdinand VII was completed; it is "7,500 meters long," has a pipe which measures only 18 inches, and receives also from the Almendares its water supply, which is inadequately filtered through pebbles and sand. The combined supply of the Zanja and of this aqueduct proving insufficient and unsatisfactory, the magnificent aqueduct of Isabel II, or of the Vento, was begun in 1859. Its supply is derived from the pure and inexhaustible Vento Springs, on the very edge of the Almendares River, nine miles distant from Havana.* This aqueduct has already cost $3,500,000, as is alleged, and will cost nearly as much more to complete. It is a noble monument to the engineering skill of Colonel Albear, and when completed will furnish Havana with an ample supply of most excellent water. It has advanced beyond a point opposite to and at no great distance from where the aqueduct of Ferdinand VII begins, and a temporary connection was established in 1878 between the two, so that this aqeduct now conveys to the city the clear, pure water of the Vento Springs, and not the water of the Almendares. Thus, a better, but no larger supply is delivered through the small and very inadequate pipe of the aqueduct of Ferdinand VII. As results of these two supplies, Messrs. Ariza and Herrera, the official city engineers of Havana, reported in 1880 as follows: "About 2,800 houses are now supplied from the Vento, and about 2,450 houses by the Zanja from the Almendares. The remaining 11,000 to 12,000 houses are supplied from both sources, since their inhabitants buy it from street vendors, who procure it from the public fountains, of which the greater number are supplied from the Vento. There is little well or cistern water used, only the surburban ward of Vedado is supplied exclusively in this way." This sparsely inhabited Ward has about 1,500 population, and the reputation of being very healthy. Messrs. A. and H. also state: "Havana's two sources of supply furnish 17,000 cubic meters of water every 24 hours," but this is presumed to be an error, possibly of translation, since Pezuela states, as above cited, that the daily supply from the Zanja alone is 20,000 cubic meters. The cheapest supply is $40 per annum for one small fosset.

The above facts show that more than two-thirds of the inhabitants of Havana purchase their water in little kegs and carboys from street vendors. The very large number thus supplied belong of course to the poorer class, whose other insanitary evils

* All three of the water supplies to Havana, the Zanja, and the two aqueducts of Ferdinand VII, and of the Vento, proceed from the Almendares, and run their course near to each other; the farthest to the west being the Zanja, and to the east the Vento.

are greatest, and whose need of an abundant supply of pure water is the most pressing. Naturally a quantity most inadequate for hygienic purposes is thus purchased. This same evil exists in Matanzas, Cardeñas, Cienfuegos, and most other Cuban towns, and is believed to be even greater in these than in Havana.

The insanitary evils which result from this general insufficiency of water in a tropical climate are much greater than would ensue farther north. When bathing becomes difficult, and washing so exorbitant that it costs from twenty to thirty cents in gold to have a gentleman's shirt washed, it is not strange that personal cleanliness should be so little attended to that an unusually large portion of the people are offensive to the smell. This lack of cleanliness extends within the houses, into the unpaved streets, the stables, markets, and for the most part everywhere. Further details are useless, as also insistance upon the pollution of the soil, and of the air, and of other manifest evils, which necessarily result from an insufficient supply of water. It should never be forgotten that "clean water, adequately used, is among the simplest, safest, best of antiseptics," and that the people of Havana and other Cuban cities are very insufficiently supplied with this antiseptic.

However, the student should be cautious in drawing hasty conclusions and in overestimating the influence of an inadequate supply of pure water on yellow fever especially. No one will deny its evil influence generally on health, but it does not follow that any such influence is exercised especially on yellow fever. Preceding facts show that during the 76 years—1515-1591—when Havana was worst supplied with water, there was no yellow fever; that during the following 170 years—1591-1761—when the supply, though improved, was still inadequate and impure, there also was no yellow fever, unless probably during the very few years, 1648-1655; that yellow fever began in 1761 and continued until 1835, under the same conditions of water supply as had existed during the many preceding years of exemption from the disease. And finally, that the improved supply in 1835 and again in 1878 failed to make any perceptible impression on the prevalence of yellow fever.

There is still more discouragement in the following facts: Until recent years Vera Cruz suffered very greatly from a deficient supply of water, and Dr. Heinemann, of this place, writing in 1879, stated that Dr. Fuzier, an able French surgeon in charge of the military hospitals at Vera Cruz, during the French occupation of Mexico, 1861-'66, indulged in sanguine hopes that yellow fever would be greatly ameliorated by the introduction of the water of the Jamapa (the water-works being then near their completion), by the erection of public baths, &c., and he adds, now for twelve years Vera Cruz has had this water of Jamapa flowing out of numerous fountains and through all the gutters, the houses are well supplied, the baths are well attended, the streets are the best policed in Mexico, and yet yellow fever has continued to prevail and has caused the three frightful epidemics of 1875, 1877, and 1878. "It therefore," says Dr. H. "evidently follows that filth *per se* has nothing to do with yellow fever, and that the statements of many authors in reference to this are exaggerated. While many will concur with Dr. H. in deprecating exaggerations, and in discrediting the *de novo generation* of yellow fever by filth, few will admit that his premises justify his apparent conclusion that filth has "nothing to do with yellow fever." It is quite certain that Vera Cruz has not yet become a model for the future city of Hygeia, notwithstanding the abundant water supply from the Jamapa.

B.—SOIL, DRAINAGE, ETC.

The surface soil of Havana, consists for the most part of a thin layer of red, yellow, or black earths. At varying depths beneath this, often not exceeding one or two feet, lie the solid rocks. These foundation rocks are, especially in the northern and more modern portion of the city towards the coast of the sea and not of the harbor, Quarternary and especially Tertiary formations so permeable that liquids emptied into excavations are absorbed and disappear. In the southern and greater portion of the city, these rocks are of cretaceous formation, and so much less permeable that sinks and other excavations readily fill to overflowing. About 20,000 persons or one-tenth of the population live on land reclaimed from the sea, in large measure, by dumping on garbage and street refuse.* Much of this reclaimed land was formerly mangrove swamps, and Havana still lies adjacent to these breeders of malarial poison. There are few if any towns in Cuba which are not subjected to malarial effluvia from mangrove or other swamps, and many of these suffer to greater extent than Havana.

The highest point within or adjacent to Havana is the summit of Jesus del Monte, 220 feet above the sea, but the number of inhabitants living even 100 feet above the sea is extremely small. In fact not more than one-fourth of the population live over 50 feet above the sea, while at least 20,000 live on ground less than 7 feet and 35,000 on ground from 7 to 13 feet above high tide. In many privies the contents rise and fall with the tide, and in a much larger number of houses, even in some elevated many

* Messrs. Ariza & Herrera reported a population of 3,000 on the reclaimed parts of the first district, 8,000 on parts of the third and fourth, 5,000 on part of the fifth, and 600 on part of the sixth district.

feet above the sea, a moisture mark is plainly perceptible high on the walls. A heavy rain or a high tide with a north wind inundate the lowest floor of many houses in Havana.

In Cuban cities generally good drainage is never found except in such comparatively inextensive parts where nature required little or no assistance. Even in Havana, the oldest and wealthiest city, the visitor is often astounded, especially in the rainy season, by impassable mud holes, and green, slimy, stagnant pools in the streets and in the back yards. This condition was found even in the Pueblo Nuevo ward, which is located so admirably for good drainage that little labor would be required to make it perfect.

Messrs. Ariza and Herrera reported, "Havana has no sewers save in a few principal streets. These sewers have been built at interrupted intervals, and without reference to any general plan for drainage They are seldom cleaned, and are generally obstructed in part or wholly with sediment or filth from the streets, and exhale offensvie odors. As the sewers are few in number, the greater part of the water of the city empties through the streets into the harbor or the sea, but the quantity flowing into the sea is comparatively small." Mr. A. H. Taylor, a civil engineer, thoroughly informed on this subject, testified that the sewers of only three streets subserved any good purpose whatever, and that the remainder were so defective that the city would really be much better off without them. Covered by gratings which have large interspaces, the dirt and refuse of the streets find such ready entrance that a number of these sewers were seen filled up, with apparently solid materials, to within a few inches of the gratings. Since very few houses or privies are connected with sewers, these are less offensive than they would otherwise be, but no one who has seen them can find any words except of unhesitating condemnation for their grossly defective structure.

The causation or propagation of yellow fever has been repeatedly attributed to upturning of the earth, and this is prohibited during the summer in New Orleans, and perhaps in other places in the United States. If there be any such prohibition in Havana, this was not enforced during the summer of 1879.

C.—THE STREETS.

The older a Cuban city, or any part thereof, the narrower the streets. One-fifth of the population of Havana live within the now demolished walls, and this "intramural" population possesses streets so narrow that on every corner is posted either "up" or "down," to indicate to all vehicles that they must pass only in the direction indicated. As time extended the city farther and farther beyond its walls the streets gradually became wider, until some attained the ordinary dimensions usually found in the United States. Matanzas, Cardeñas, and Cienfuegos were founded subsequently to Havana, in the order mentioned; therefore Matanzas has many narrow streets, but not as narrow as Havana; Cardeñas few, and Cienfuegos none. The narrower the streets, the smaller, usually, the house lots, and the more defective the ventilation of the houses; however, it should not be forgotten that these are for the most part one-story houses, and that wider streets afford no better ventilation to houses with several or many stories. Less than one-third of the population live on paved streets, and these are as well paved and kept as clean, it is believed cleaner, than is usual in the United States. The remainder live on unpaved streets, which for the most part are very filthy. Many of these, even in old and densely populated parts of the city, are no better than rough country roads, full of rocks, crevices, mud-holes, and other irregularities, so that vehicles traverse them with difficulty at all times, and in the rainy season they are sometimes impassable for two months. Rough, muddy, or both, these streets serve admirably as permanent receptacles for much decomposing animal and vegetable matter. Finally, not less, probably more, than one-half the population of Havana live on streets which are constantly in an extremely insanitary condition, but these streets, though so numerous, are not in the beaten track of the pleasure tourist, in which capacity the writer, in 1856, spent ten days in Havana without witnessing many of the evils now testified to with emphasis.

In respect to the streets of Havana, Messrs. Ariza and Herrera reported in 1880 as follows: "In the old intramural city, in which live about 40,000 people, the streets vary in width, but generally they are 6.8 meters [about 22 feet] wide, of which the sidewalks occupy about 7½ feet. [In many streets the sidewalk at each side is not even 18 inches wide.] In the new, extramural town the streets are generally 10 meters [32.8 feet] wide, with 3 meters [nearly 10 feet] for the sidewalks, and 7 meters [23 feet] for the wagon-way. There are few sidewalks in any except in the first four of the nine city districts. Considerably more than two-thirds of the population of Havana live on unpaved streets."

D.—HOUSES.

More than two-thirds of the population live in densely inhabited portions of the city, where the houses are crowded in contact with each other. The average house-lot does

not exceed 27 by 112 feet in size. There are 17,259 houses, of which 15,494 are one-story, 1,552 are two stories, 186 are three stories, and only 27 are four-story houses, with none higher. At least twelve in every thirteen inhabitants live in one-story houses; and as the total civil, military, and transient population exceeds 200,000, there are more than twelve inhabitants to every house. Tenement houses may have many small rooms, but each room is occupied by a family. Generally, the one-story houses have four or five rooms; but house-rent, as also food and clothing, are rendered so expensive by taxation, by export as well as import duties, that it is rare for a workman, even when paid $50 to $100 a month, to enjoy the exclusive use of one of these mean little houses. Reserving one or two rooms for his family, he rents the balance. This condition of affairs is readily understood when it is known that so great a necessity as flour cost in Havana $15.50, when its price in the United States was $6.50 per barrel.

In the densely populated portions of the city the houses generally have no back yard, properly so called, but a flagged court, or narrow vacant space into which sleeping-rooms open at the side; and in close proximity with these, at the rear of this contracted court, are located the kitchen, the privy, and often a stall for animals. In the houses of the poor, that is, of the vast majority of the population, there are no storerooms, pantries, closets, or other conveniences for household supplies. These are furnished from day to day, even from meal to meal, by the corner groceries; and it is rare, in large sections of Havana, to find any one of the four corners of a square without a grocery—a fact which teaches forcibly the necessities of the poor, their improvidence, and the discomfort of their homes.

The walls of most of the houses in Havana are built of "mamposteria," or rubble masonry, a porous material which freely absorbs atmospheric as well as ground moisture. The mark of this can often be seen high on the walls, and Messrs. Ariza and Herrera report that this varies from 2 to 7 feet in the houses generally. The roofs are excellent, usual y flat, and constructed of brick tiles. The windows are, like the doors, unusually high, nearly reaching the ceiling, which, in the best houses only, is also unusually high. The windows are never glazed, but protected by strong iron bars on the outside, and on the inside by solid wooden shutters, which are secured, like the doors, with heavy bars or bolts, and in inclement weather greatly interfere with proper ventilation. Fire-places with chimneys are extremely rare, so that ventilation depends entirely on the doors and windows, which, it should be stated, are by no means unusually large in most of the sleeping-rooms of the poor. Generally in Havana, less generally in other cities, the entrances and court-yards are flagged with stone, while the rooms are usually floored with tile or marble. With rare exceptions, the lowest floor is in contact with the earth. Ventilation between the earth and floor is rarely seen in Cuba. Messrs. Ariza and Herrera report that in Havana the average height of the ground floor is from 7 to 11 inches above the pavement, but in Havana, and more frequently in other Cuban towns, one often encounters houses which are entered by stepping down from the sidewalk; and some floors are even below the level of the street. In Havana, some of the floors; in Matanzas, more; in Cardeñas and Cienfuegos, many are of the bare earth itself, or of planks raised only a few inches above the damp ground.

The privy and the sink for slops, the open kitchen shed, and the stable immediately adjoin each other, confined in a very contracted space close to sleeping-rooms. The privy consists of an excavation which often extends several feet laterally under the stone flags of the court. Even if the sides be walled, the bottom is of the original porous earth or subsoil rock, thus permitting widespread saturation of the soil. The privy is never emptied until it will hold no more, which seemed generally to occur in from five to ten years, and this is accomplished by transportation in buckets to casks at the *front* door; and Messrs. A. and H. state that during heavy rains the contents of the privies and sinks are at times thrown into the streets, from whence they are removed by the flow of the rain-water. So many privies are filled to overflowing and unserviceable that an American, twenty years resident in Havana, assured me that in many streets itinerant chamber-pot venders plied a prosperous trade, and that these conveniences were daily used by many, the contents emptied into the streets, and there concealed by a thin covering of loose dirt. Very rarely, indeed, has a Cuban privy a ventilating pipe, and hence belches forth its nauseous odors throughout the house, often in summer even to the front door. Nothing more stinking, nasty, and unwholesome than the privy system of Havana and of Cuba can be conceived. It would not be possible to make it worse. In juxtaposition with the privy is another excavation or sink to receive the filthy refuse water of the kitchen, laundry, and household generally; for, police regulations prohibit the discharge of such refuse fluids into the streets, except during rains. These refuse fluids are said to undergo a decomposition which render them intolerably offensive. They notably aid the contents of the privy in foully saturating the soil beneath the house. Such is the proximity of the stable to sleeping apartments that farcy would be more frequent if horses were more afflicted. Garbage, by police regulations, should be deposited daily at the door, and, collected each night, should be transported out of town; probably these regulations are comparatively well executed.

En masse, the houses of the people generally appear comfortless and cheerless, and reminded me of a rough dirty camp of disorderly volunteers. Water is so ill supplied that the people are not cleanly either in their houses or their persons, and the condition of these houses has been inadequately portrayed, if the facts are not accounted for, that, in the summer season at least, a fæcal or urinary odor, due to man or beast, prevails generally; and that, in traversing the streets, a musty, nauseous, or excrementital odor is distinctly perceptible as it oozes from the front doors and windows (these habitually open without any intervening space directly on the street) of nearly every house. At times a fæcal odor from the harbor was distinctly perceived when the wind blew from the harbor into my room a hundred feet distant. With time, one's olfactory nerve becomes benumbed and fails to give warning of the stench, if faint, from the privies and the stables.

It may be stated of houses in Cuba, generally, that Cuban towns present a novel, picturesque, and pleasing appearance at a distance, but that a close inspection tends to convert this pleasure into disgust. All of these towns are characterized by low, mean-looking one-story houses, with floors on a level with the streets; by streets which are unpaved and often very muddy dirt roads; by filth, squalor, and dirty people everywhere. Outside of the towns, often in their outskirts, the great majority of houses are mere palm-leaf huts, which have a single opening and a dirt floor. These are more wretched dwellings than the former negro slaves of the United States enjoyed; dreary within, they defy domestic comfort and decency, and suggest thriftlessness, poverty, barbarism. When houses have back yards, these are usually repulsively crowded with dilapidated furniture and boxes, with old clothes, cocoa-nut rinds, and an astonishing variety of disorder and filth.

There has been no intention to convey the idea that houses may not be found in American cities as foul as they can be, and, therefore, as foul as they are found in Cuba; but in the former these evil conditions are seen as exceptions, confined to narrow, disreputable limits, while in Havana these conditions in the "homes of the poor" are widespread and general. Moist, foul, stagnant air, confined low to the ground, is found everywhere, so everywhere can be seen the refuse of fruits and of vegetable substances, furnishing abundant material for decomposition, while numerous turkey-buzzards, roosting on the trees and house-tops of populous cities, sufficiently testify to ample supplies for animal putrefaction. These gross insanitary evils are as abundant in Havana, where yellow fever always prevails, as in Canton and Bombay, where this disease never occurs.

Of the various evils recounted in connection with the subject of houses, there are two which deserve special attention. Many facts, besides those associated with the holds of vessels, justify the belief that the growth of the poison of yellow fever is specially favored in warm, moist, ill-ventilated places, where air is closely confined. The low-lying floors touching the earth, the small densely packed houses, the unusually contracted ventilating space in their rear, the large unventilated excavation for privies and sinks, all furnish, as is firmly believed, the most favorable breeding places for the poison of yellow fever. In addition, statistics prove that in great cities subjected to their ordinarily unfavorable conditions, the denser their population the sicklier and shorter the lives of their inhabitants. Common sense and experience unite to teach that the denser a population the more widespread and frightful the havoc, especially of communicable diseases. Elsewhere will be found a special report on the density of the population of Havana compared with numerous other cities, and it therein appears that more than three-fourths of the people of Havana live in the most densely populated localities in the world. A tropical climate renders this enormous evil still greater. Not only in Havana but throughout Cuba the average number of inhabitants to each house is unusually great, and this fact enables us better to understand the great prevalence in Cuba of those communicable diseases which its climate and other local conditions favor.

In connection with the homes of the living and of their air-polluting causes, the following facts respecting the homes of the dead deserve attention, as these facts are calculated to guard us against hasty conclusions: Sanitarians were greatly offended by the burial of the dead of Havana in its churches until 1806, when the "cemetery of Espada" was established outside the walls. In the course of years the growing city surrounded this cemetery, and to this was again attributed, among other insanitary evils, a bad influence on yellow fever. Overcrowded with more than three hundred thousand dead bodies this cemetery it was closed in 1871, since when all the dead of Havana have been interred in the new "cemetery of Colon," which is admirably located and too distant from the population to exercise upon it any evil influence. It is noteworthy that there has apparently been no abatement in the prevalence of yellow fever.

E.—THE HARBOR.

The beautiful harbor of Havana is inclosed by graceful hills, five of which are surmounted by picturesque forts; its pleasingly diversified banks are covered either with variously colored houses, or with verdure which encroaches upon the water. The

narrow entrance, about 400 yards in width and 1,200 in length, opens into the irregular harbor, which has three chief coves or indentations, termed "ensenadas." The extreme length of the harbor from its sea-entrance to the limit of the most distant ensenada is three miles; and its extreme breadth is a mile and a half. But, within the entrance, the average length is only about one, and the average breadth about two-thirds of a mile. However, because of the irregularly projecting points of land which form the ensenadas, there is no locality in the harbor where a vessel can possibly anchor farther than 500 yards from the shore. Its greatest depth is about 40 feet, but the anchorage ground for vessels drawing 18 feet of water is very contracted, not exceeding one-half the size of the harbor. The number of vessels in this harbor in 1878 at any one time varied from forty-seven to two hundred and twenty-seven, and the average number exceeded one hundred, so that it is rare to see any one vessel more than a very few hundred feet distant either from another vessel or from the shore. The rise and fall of the tide does not usually exceed 2 feet, and the water is not otherwise replenished except by six little brooks, which, even including the so-called rivers Luyano and Martin Perez, are utterly insignificant except after a heavy rain. Though pleasing to the eye, though sufficiently commodious and remarkably safe for shipping, this harbor is to the sanitarian little more than an almost stagnant pond or large open ill-drained sewer into which is daily discharged the refuse—comparatively little of it being fæcal—from more than one hundred thousand people with their domestic animals, all the filth from the numerous vessels, the blood, offal, and other refuse from more than 400 animals daily butchered, and the fæcal as well as other refuse from the chief military hospital, and probably from other houses which are rarely without some cases of yellow fever. The sewers of several forts occupied by numerous soldiers empty into the harbor, soap factories add their quota of unsavory refuse, and from the gas-works flows a constant stream of an oleaginous tarry mass, which, in calm weather, gives to a portion of the harbor an unpleasant odor and a nasty scum, which, however, may not be unhealthy. Around the fish market and at the extreme southern shore the harbor is the most nauseating and disgusting. A considerable portion of the city drains into the sea, and it would be well if all of it did, but engineers pronounce this impracticable. Much of the eastern and southern shores are destitute of wharves; many of these, where they do exist, are dilapidated, worm-eaten, rotten, and all of them serve as traps for entangling the abundant filth poured into the harbor. All along the shore, as is usual in seaports, this filth is very apparent, and this is most offensively the case along the southern shore, where the water is more stagnant than elsewhere, where the harbor is fast filling up, and where the adjacent land is low.

Notwithstanding these facts, the water of the harbor, though examined carefully and repeatedly by Dr. Sternburg, failed to present evidence of special putridity, nor did it during the summer of 1879 manifest the remarkable phosphorescence usual at this season, and for which this and other harbors of the Antilles have long been particularly noted. Several high authorities associate the unwonted prevalence of yellow fever at Havana with the unwonted putridity and phosphorescence of the water of its harbor; it therefore deserves record that these were not present in 1879, although yellow fever prevailed with more than usual severity. It was reported that vessels of the British navy were especially forbidden to use this water on board for any purpose whatever.

The sanitarian cannot hesitate to advocate, for general reasons if not specially for yellow fever, the cleansing of the harbor, the cessation of daily additions to it of large masses of filth, and the replenishment of it by constant currents of pure water. To accomplish the last, it has been much insisted on, in the United States, as well as in Cuba, that canals should be dug. Out of Cuba it ought to be better understood, that Havana is by no means deficient in highly educated, skillful, practical engineers, who are fully alive to the sanitary interests of the city, and to the merits of this special subject. Among these, Colonel Albear stands pre-eminent, and in September, 1879, he delivered before the Academy of Sciences an extremely able address on this subject, which is so full of instruction, on other local conditions also of interest to the sanitarian, that this address has been translated and is presented (chap. XXII), as a most interesting part of this report. Colonel Albear seems to have conclusively demonstrated the impracticability of these proposed canals; and my own conviction is that if practicable they could not possibly place the small harbor of Havana in as favorable sanitary condition as are by nature the large harbors of Matanzas and of Cienfuegos, where yellow fever none the less prevails.

BALLAST.—Opposite to Havana, on the eastern and southern shore of the harbor, there are five depots for ballast, which is often deposited on the very edge of the harbor, with its lowest layer in contact with the water. It is composed, for the most part, of friable porous rocks and the dusty detritus thereof, intermingled often with sand and earth, and not infrequently with human excretions. Even the hardest and densest of these rocks absorb a large amount of air, and of water after being dried in the sun. Considering this fact, together with the facts that science is still very igno-

rant respecting fomites, and that outbreaks of yellow fever have been frequently attributed to ballast from infected ports, ordinary prudence dictates that such ballast should be treated with suspicion, and, therefore, as dangerous. It should also be remembered that vessels in ballast sail from Cuban ports, especially from May to December, when the export trade of Cuba is least, and to southern ports of the United States. Of the five depots for ballast, one is within the very town of constantly infected Regla and deserves special condemnation; it receives freely fluids from the streets, and human excretions, and in the nook of the harbor where this depot is situated vessels frequently become infected. Another depot, almost as objectionable, is at Casa Blanca, but this is apparently little, if at all, used now. The other three places of deposit are less objectionable.

GENERAL OBSERVATIONS.—In proof that the insanitary condition of Havana and the causes thereof have in nowise been exaggerated, nor aught written with either the thoughtlessness or the malice which not infrequently characterize the comments of a casual visitor to a foreign country, many confirmatory quotations could be given from the writings of distinguished resident physicians. Two examples only will be cited, one from an American, the other from a native resident, each proving, among other things, that the people of Havana have able instructors at home and need no commission from abroad to teach them the evils of their condition and the remedies. As elsewhere, the means to secure the application of the remedies are lacking.

Dr. D. M. Burgess, resident in Havana since 1866, and since 1879 United States sanitary and quarantine inspector, reported to a United States Congressional committee on February 12, 1879, the following among other things:

"Havana is admirably located on elevated ground which readily admits of excellent drainage and sewerage; yet, while perhaps one-tenth only of the streets have sewers, these are so defective that they are for sanitary purposes worse than useless; large pools of dirty water, pregnant with filth, suspiciously embossed with green, all kinds of slops and urine, are found in many of the streets. Heaps of excrement, garbage, and dead animals, putrefying in the tropical sun, are common in and around the city. The universal household receptacle for human excrement and household slops is merely an excavation in the rear of the house. The effluvia therefrom pervades the houses, and the fluid contents saturate the soil and the soft porous coral rocks on which the city is built. Hence, all well-water is ruined, and every ditch dug in the streets exhales an offensive odor. Thus Havana may be said to be built over a privy. Violations of sanitary laws are so frequent that one begins to suspect that it is made a study how to break them most flagrantly."

Dr. F. Zayas, a distinguished physician, and one of the members of the Spanish yellow fever commission, could furnish an excellent quotation from the second volume of the Anales, but the following in the third volume of the same is preferred. It is by Dr. J. G. Lebredo, a most eminent and estimable physician, also a member of the Spanish commission. The translation, though free, is faithful:

"To one who asked an inhabitant of the Pontine marshes how life was there possible, the answer was given, 'We do not live, we die here.' So might we, who live in Havana and other parts of Cuba, reply to a like question. Look at the extensive ward of Jesus Maria, which, located on naturally low ground, has been gradually raised by dumping upon it the refuse and garbage of this city. Look at the immediate shore of the harbor, and see the vast extent of beach, covered by marsh vegetation and organic detritus! Who of us has not had his senses rebel against the disgusting and pernicious influences emanating from the little stream, which, flowing under the Chavez Bridge, traverses the extreme southern part of Havana, a stream polluted by a tan-yard, reddened by the blood and corrupted by the offal of the slaughter-houses? Look at the residences between the admirable and much-frequented Belascoin and Infanta avenues, and see their adjacent piles of filth, in despite of a law which prohibits any such deposits within 100 meters of highways and residences. Regard other avenues, throughout whose whole length gutters are seen, exposing to the energetic action of our ardent sun their disgusting contents! Behold our cemetery within the city limits, and our sewers, so arranged that they collect within our walls the greater part of our own filth! Look at our many streets which collect rain water in stagnant pools, and, impassable to vehicles, are covered with dark green mold! See the vacant places, where, for miles around, our trees have been felled without a thought that each stroke of the ax has destroyed one more safeguard to health! Aggregated in vast number upon a very limited site, we have been desolated by epidemics of cholera, small-pox, dysentery, croup, and almost every known epidemic disease; we have annually to combat intermittent, bilious, and pernicious fevers. We have yellow fever constituted an endemic among us; and we suffer from all those baneful insanitary evils which have been denounced again and again, but which must be constantly declaimed against as long as they exist. These fatal conditions so surround us that we constitute, as the wise Humboldt well expressed it, 'a society of convalescents;' in fine, 'we do not live, we die here.'"

The facts now detailed conclusively prove that the sanitary condition of Havana, as

also of other Cuban ports and towns, is extremely unfavorable, and that there are many manifest causes for this evil condition. These causes may be briefly summarized as follows: An equable, warm, damp climate, eminently favorable to decomposition, to putrefaction, and to the growth of living organisms; the proximity of swamps and stagnant pools, prolific breeders of malarial poison; an inadequate supply of water, which is defective, partly in quality and wholly in quantity; very bad drainage and sewerage, with widespread subsoil and house-wall moisture; a most disgusting privy system and an insanitary construction of the houses, whereby many ill-ventilated traps are provided for warm, damp, and foul confined air; a polluted harbor constantly frequented by filthy ships; and, finally, an unparalleled density of population in certain urban localities, and generally throughout Cuba, in the houses. By such causes the pure air indispensable to healthy life is incessantly and grossly polluted.

For more minute details on the subjects of this chapter, so far as Havana is concerned, the reader is referred to the statistical data contained in the admirable tables, in chap. XXIII, of the official engineers of the city of Havana, Messrs. Ariza and Herrera.

CHAPTER V.

CAUSES OF THE "SO-CALLED" ENDEMICITY OF YELLOW FEVER IN HAVANA AND IN OTHER PLACES IN CUBA.

The concluding summary in the last chapter shows that all the insanitary conditions attributed by any theory, it makes no difference which one, to account for the prevalence of yellow fever in Havana, are there present. Is the disease *originated* in foul ships within the American tropics? Such ships superabound there. Is the disease both originated and propagated by decomposing and putrefying filth? This is likewise superabundant. Is the disease never originated anywhere, any more than vegetables or animals are now originated, but being introduced is it propagated, by certain conditions, some of which are known and some are unknown? The known conditions are manifestly present, and the facts prove that not less surely the unknown conditions are there. In respect to all the known, and presumably the unknown, local insanitary conditions so prevalent in Havana, the great predominant fact is that all of these exist with equal intensity in the Asiatic tropics without generating the poison of yellow fever; but while no one can assign a valid reason why this poison, if there, should not be propagated, all well understand that there is no more reason it should be there than that vegetables and animals peculiarly American should be. Failure of transportation is the cause why the latter have never appeared, and therefore have never been propagated in tropical Asia, and this is the sole cause which can satisfactorily explain why the poison of yellow fever has never appeared nor been propagated there. In the American tropics, even at Havana itself, the facts are not less decisive that all its insanitary evils could not generate the yellow-fever poison, and therefore could not propagate it unless introduced, and introduced at a time when the requisite unknown as well as known conditions were favorable. There is no reason to doubt, but every reason to be assured, that the physical geography, the geology, the meteorology, and all the insanitary conditions which have characterized Havana and Cuba since 1761, were identically the same during the two and a half preceding centuries, apparently of total and certainly of habitual exemption from yellow fever, Moreover, there are in Cuba large towns which, in spite of unaltered local conditions were ravaged by yellow fever for the first time during the lives of still living residents, and there are at this day localities still exempt from the disease. The facts are similar as to all others of the Antilles.

Climatic and ordinary local conditions fail, then, to explain the origin and prevalence of yellow fever, and there is no escape from the conclusion that the persistent annual prevalence of this disease in Havana since 1761 must be due to conditions which were not present in 1760 and in the years prior thereto. Therefore, the causes of this endemicity must be sought in those conditions which have been changed, and not in those which have remained permanent. Some of the conditions which favor yellow fever are unknown; none the less, the favoring conditions which are known may suffice to account satisfactorily for the fact that the disease has been an endemic in Havana only since 1761.

In what conditions, which have since persisted, did Havana undergo marked change in 1761? Havana and Cuba were then aroused from a condition of prolonged lethargy to one of unparalleled and constantly increasing prosperity, which vastly increased Havana's commercial intercourse, foreign as well as domestic, and both the number and the density of its population. Since these are the sole conditions which were changed, they must be the conditions which caused yellow fever to become endemic

They certainly do not suffice to generate this poison, but, among other necessary conditions, these are essential to its propagation and dissemination.

History, as trustworthy as it ever is on such a subject, records the means by which the poison was transplanted in Havana, the place of exportation, the names of the importing vessels, and the passengers specially instrumental in the transplantation. Preparing for a threatened siege by the English, Havana received important assistance from Vera Cruz, at that time the most important military post of Spain in the Gulf of Mexico. Spanish men-of-war conveyed in 1761 from Vera Cruz to Havana, among many other things and persons, condemned prisoners to work upon the fortifications. These prisoners, say the historians of the time without a dissenting voice, transplanted in Havana, unusually crowded by those preparing to defend the place, the poison of yellow fever. It grew apparently upon what it fed on, and in 1762, when Havana was captured by 30,000 English soldiers and sailors, the poison found a still ampler supply and apparently continued to grow. The English conquerors, as all even of the Spanish historians admit, brought prosperity instead of desolation to the country. Overthrowing some abuses, they reanimated the slave trade, and thereby wonderfully promoted the agriculture of Cuba and the commerce and population of Havana. The uninterrupted annual increase of the population and commerce of Havana from 1761 to the present time is without a precedent in the Antilles. Presuming that the transplanted poison found in Havana the climatic and other local conditions requisite for its propagation, its exceptionally persistent annual growth seems specially dependent on the exceptionally persistent annual increase of immigrants. No one can doubt that all other favoring conditions being the same, the prevalence of yellow fever would be most persistent in those places where unacclimated immigrants arrived most continuously and in greatest number. This has been pre-eminently the case with Cuba and especially with Havana, comparing these with other islands and cities of the Antilles; and it is not doubted that this is the chief reason that yellow fever has been, since 1761, more persistent and widespread in the latter than in the former. At length localized in Havana, the great commercial and military center of Cuba, the poison found improved and more rapid methods for its transplantation to other localities and also became localized in those which furnished, like Havana, a large annual accession of immigrants. Until 1819, the only conveniences for disseminating the poison were sailing craft on the one hand and wretched dirt roads on the other. Steam navigation, introduced in 1819, gradually increased the intercourse between Havana and the principal ports of Cuba, and steamship lines to foreign countries, inaugurated in 1848, have accomplished the same end as to foreign ports. In 1837 the first railroad was opened; in 1852 Cuba had 360 miles, in 1860 794 miles, and in 1873, since when little has been done, 829 miles of railroads, most of which center at Havana, linking it more closely not only to the principal sea-ports, but also to inland towns.* Cuban testimony is that yellow fever has become more widespread with the increase in these methods of transportation, and this testimony is confirmed by like experience at Vera Cruz and at New Orleans. The Cuban insurrection, 1868–1878, forced Spain to send to Cuba a number so large of unacclimated soldiers that during some of these years the Spanish army numbered 100,000 men. Duty called these soldiers to the eastern mountainous section of the island, where yellow fever least prevails, and where, in many places, it was unknown. Even in these last where the natives, though susceptible to the disease, had never suffered with it, both soldiers and natives were so frequently attacked that it was not doubted that the soldiers carried the disease with them wherever they went. So deep an impression did these often-repeated occurrences make that in 1879 not one physician was encountered in Cuba who discredited the portability and thereby the communicability of yellow fever, while many of these did believe in its local origin, and in its personal non-contagiousness.

In accounting for the unusual prevalence of yellow fever in Havana and Cuba compared with others of the Antilles, it is well by repetition to emphasize the following facts: Cuba differs from these in that its products are more valuable, and therefore its commerce by land as by sea is more extensive, and its population, unacclimated and acclimated, is more numerous and is aggregated more densely in cities which are in frequent and rapid intercourse with each other. In addition, Cuba makes no such efforts to limit the spread of yellow fever as have apparently proved successful in Martinique and others of the West Indies. None the less, in Cuba and Havana, as everywhere else in the world, the poison of yellow fever shows a fortunate tendency to become dormant annually, and even at times to die out. This tendency is certainly influenced by lowered temperature, by lack of unacclimated material, and by undetermined causes other than these; inasmuch as yellow fever often fails to prevail as usual, though there be present patients sick with the disease, the usual high temperature, and the usual number of the unacclimated, as was strikingly illustrated throughout Cuba in 1866. Our present knowledge justifies the hope that, if the periods when this

* Details of the preceding facts recorded in this chapter will be found in chaps. XVII and especially XIX.

tendency to die out was very manifest were utilized in efforts for protection, even Havana might be freed from the poison of yellow fever and require a fresh importation for the renewal of the disease.

So far is Cuba from making any efforts to control yellow fever that much is done to favor its dissemination. Some examples will illustrate this. In July, 1879, the chief military hospital at Havana, located on the edge of the harbor in one of the notoriously most infected wards and localities of the city, was inspected. It contained many cases of yellow fever, some of which were originating therein daily. A large room on the ground floor of this hospital contained new blankets and other hospital supplies of clothing in very large quantities, and to the value of $80,000, and it was found that these supplies were for *distribution* to the other military hospitals scattered over the island.

The board of health of Santiago de Cuba, the Cuban city next to Havana in size and in commercial and military importance, officially reported in 1879 as follows: "Formerly yellow fever was unknown in adjacent rural towns, and even in settlements on the limits of this city, but during the war the disease was known to prevail in the military hospitals established in camps more than 1,000 feet above the sea, prevailing therein epidemically and by infection. In these cases the disease was undoubtedly imported, either by clothing or persons. For it is well known that these hospitals were provided with the necessary supplies by the central hospital located in this city, and that communication between said rural hospitals and this city and harbor were constant." Asking for an explanation of the appalling recklessness which resulted in storing military supplies intended for distribution to non-infected posts in the very heart of the most intensely infected places, a distinguished surgeon of the Spanish army replied with sorrow that his government paid better attention to economizing its money than to savingthe lives of its soldiers. While all governments still do this, at least to some extent, it is hoped that few can offer such reckless examples as those just cited.

Cuba has for years been cursed with a deteriorated paper currency, much of it is so dirty that it stinks, and some of it is so foul that it has been seen conveying, even sticking fish scales from person to person. Rags are specially condemned by laws as the most dangerous fomites, and the present Cuban paper currency deserves equal condemnation.

While the government commits acts like these, which facilitate the dissemination of yellow-fever poison at home, it is not surprising that even less regard should be shown to disseminating the poison abroad. It was reported to me by a high official that during one or more of the past ten years the Spanish authorities in Havana issued clean bills of health to all foreign vessels during the yellow fever season, and when the disease was prevailing with its usual severity. After October 4, 1879, the same thing occurred, although there were on that day not less than eighty cases of yellow fever in the city and nine infected vessels in the harbor.

Such official acts as those now stated are the more astounding when associated with the fact that by Spanish law yellow fever is a "contagious disease," and that in the official reports of every board of health and public hospital it is entered side by side small pox, under the heading of "enfermadades contagiosas." Sufficient has now been stated to compare Spanish practice with the theory of Spanish law and Spanish medical officials, and also to show that if these theories of yellow fever be correct, then the exceptional prevalence of yellow fever in Cuba, as well as its importation thence to foreign countries, needs little further explanation. Having the poison, all the climatic and other local conditions requisite for its propagation, and constant supplies of unacclimated food for the poison, ample means are provided to bring the one in contact with the other.

Seeking for the causes of the annual prevalence of yellow fever in Havana and Cuba, it is a pertinent fact, especially to those who believe that this disease is a portable and in some wise a communicable disease, that small-pox has likewise become an annually prevailing disease. For Cuba at large it is probably as prevalent and distinctive as is yellow fever, for even at Havana, where vaccination is probably better attended to than elsewhere, there have been during the past ten years an average of 545 deaths by small-pox, the minimum for any one year having been 47, and the maximum 1,225. When it is considered that these deaths were chiefly in the civil and resident population, and that the deaths by yellow fever in the civil population, which includes many foreigners, averaged during the same time only 740 per annum, it will be admitted that small-pox is nearly as prevalent even in Havana as is yellow fever. Outside of Havana there are proportionately fewer deaths by yellow fever, and probably more by small-pox.

The official instructions of the National Board of Health directed that, in order better to determine the causes of the endemicity of yellow fever in certain parts of Cuba, there should be made "a careful examination of neighboring localities where the disease does not appear to have its cause permanently localized." Before as well as after arrival in Cuba, numerous residents thereof were found, some of them educated and

truthful, even intelligent physicians, who declared that yellow fever never occurred in this, that, or the other locality adjacent to Havana, nor even in some wards of the city itself, unless contracted elsewhere. These reports were associated with the additional assertion that said places had a fair proportion of susceptible residents, and with the notorious fact that there was rapid and incessant intercourse between these places and the unquestionably infected wards of Havana. Diligent inquiry was made for all such places, and careful investigation invariably proved that the reports were false, and that their authors had been misled, first, by ignorance of the statistics and of the attending circumstances of all cases and deaths by yellow fever in these places, and, secondly, by, in truth, a comparatively slight prevalence of the disease. The localities specially investigated, because reputed to be exempt from yellow fever, were Jesus del Monte, the Cerro, and Vedado, three suburban wards of Havana, and the adjacent towns of Guanabacoa, Marianao, and San José de las Lajas. In connection with said wards, others having a specially bad repute were investigated for the purpose of determining whether any instructive facts could be elicited by comparison. A brief special report is elsewhere published respecting these, the least and the most sickly wards of Havana; and in the special reports on the towns above named will be found the details respecting their reputed exemption from yellow fever. (See Chapters XV, XLI, LI, LXVII). Only a brief summary need be here given of the results of these investigations, which, very soon after they were begun, had no object except to determine the causes, not of the absolute exemption, as was alleged, of these places, but of their relative freedom from yellow fever. The problem was by no means easy to solve, because it was impossible to determine with accuracy the number of the population susceptible to the disease, and very difficult to collect the necessary facts as to the occurrence of yellow fever in persons who were not in the habit of frequently visiting infected Havana; for, in suburban localities, few residents refrain from this. It is believed that these difficulties were sufficiently overcome to prove that the chief cause for the comparative exemption was the very small number of the unacclimated residents in these places; but that these, though not infrequently attacked, were less liable to attack than if in the heart of Havana. Why? Of the six localities mentioned five are elevated on hills and well exposed to the winds, but Vedado, the sixth one, is located only a few feet above the sea; however, this narrow ward is built along the sea shore, and, like the other places, is well exposed to the winds. In all six places the houses occupy more space and are less crowded together, the density of the population is far less than in intensely infected localities, and the drainage is better. Hence, the explanation sought for was believed to have been found in these five facts: a small unacclimated population, free exposure to the winds furnishing better ventilation, more spacious house-lots, and more unoccupied space between these, also furnishing better ventilation; a sparse population, and, finally, better drainage.

In completing this topic, it deserves mention that Jesus del Monte, and the Cerro, notwithstanding their reputation for salubrity, front the southern extremity of the harbor, alleged to be its most unhealthy part, while Vedado, which enjoys an equally good reputation, constitutes the extreme limit of Havana on the sea-coast; and that Jesus Maria, the ward in worst repute, fronts the harbor, while the Colon ward, which is also in very bad repute, fronts the sea; both of these are built on land reclaimed by dumping on it garbage and street refuse.

Finally, respecting the various degrees of the prevalence of yellow fever in different localities, it is concluded with confidence that, wherever in Cuba a town exists which has the greatest commercial intercourse, the most numerous unacclimated population, the least exposure to the winds, and houses the most crowded together, densely inhabited and filthy, the worst ventilated and drained, there a town will be found wherein the endemic prevalence of yellow fever is most marked.

The connection of climate with the prevalence of yellow fever is of unquestionable importance, and a special report on this subject will be found in Chapter XI.

CHAPTER VI.

THE MEANS WHEREBY "THESE INSANITARY CONDITIONS CAN BEST BE MADE SATISFACTORY."

"*Sublata causa, tollitur effectus.*"

If the two preceding chapters have subserved their purpose, little need be said in the present one. To rectify the insanitary conditions of Havana and of other ports it is manifest that all the causes thereof must be removed. Pure water must be supplied in unusual abundance to the poor as well as to the rich; the swamps and lowlands must be drained and raised with rock and earth instead of with garbage; old sewers must be reconstructed and new sewers be constructed to diminish subsoil moist-

ure and subserve all other sanitary purposes which sanitation requires of them; the streets must be in large number widened, regraded, and so paved or repaired that they can be readily kept clean; the houses must be in very large proportion torn down and reconstructed on a different plan; the excavations for privies and for refuse water must be filled up and abandoned and a new system be introduced; the stables must be removed, at least from close proximity to sleeping apartments; the harbor and its shore must be cleansed and kept so; and, finally, the filthy habits of the common people generally must be reformed and their ignorance of the means by which to protect themselves from disease must be fed with knowledge. To accomplish all this in Havana alone would require millions of money; but these requisite millions expended in sanitary engineering alone would correct these evils only in part. However, since the financial problem is a most important one, some of its factors will be stated.

It is estimated by experts in such matters that the sanitary engineer would require not less than $20,000,000 to correct some of the most glaring insanitary evils—such as have relation to the water supply, the drainage, the sewerage, the paving of the streets, and to the harbor. Where is even this sum to come from? Spain, with one-third of a much less prosperous population than has the United States, owes a larger debt on which she cannot pay even the annual interest. Our people complain of the excessive national taxation imposed since 1861-'65; but Spain, by direct and indirect taxation, by onerous export as well as import duties, derives from the 1,400,000 people of Cuba, exhausted by the insurrection of 1868-'78, more than six times as much revenue as the United States derives from an equal number of its population. Thus the government renders exorbitant house rent (thereby causing overcrowding), food, clothing, and nearly all other necessaries to healthy life, and discourages the construction of more numerous and better houses, because these and all other evidences of increasing prosperity insure renewed exactions from the tax-collector.

"Since 1868 the annual expenditures of Cuba have far exceeded the revenues," which even in time of peace are in greater part absorbed by the army and navy. Besides its full share of this vast national or colonial burden, the city of Havana derives for its own support, from its 195,000 population, an additional $1,700,000 annually. Who, having a knowledge of these factors in the financial problem, can answer from whence is to come the many millions of dollars indispensable to render the insanitary conditions of Havana satisfactory?

Including the financial together with all other requisites to the end in view, the answer to the question "What can and should be done to render the insanitary condition of Havana and other ports satisfactory?" must be the same as would apply, unfortunately, to numerous other places within as well as without the United States; the people must be provided with means to become intelligent, enlightened, especially in hygiene, prosperous, and sufficiently numerous to eventually gain both the knowledge and the power necessary to correct their insanitary evils. This is not only the best, but the only means. Until their accomplishment (which the present generation will not live to witness) Havana will continue to be a source of constant danger to every vessel within its harbor, and to every southern port to which these vessels may sail during the warm season.

Since the United States commission found in Cuba only well-known causes for its insanitary condition, it was concluded with perfect confidence that "the means to render this condition satisfactory" should consist of those well-tried remedies, above indicated, which, wherever else applied, have always succeeded. So far as this condition was due to the unusual prevalence in certain localities, notably in Havana, of yellow fever, this was found dependent on causes not exceptional in quality, but unusual in quantity; hence the remedies can not be other than an unusually vigorous application of those which experience teaches are elsewhere efficient; and especially of these three, viz, efficient local sanitation to remove the propagating causes; removal of the susceptible material on which the poison feeds; and quarantine, for disinfection of infected things, and isolation of infected persons, when once the poison has been so controlled that the chief danger is from its reintroduction. The application of these remedies to Havana are excessively difficult, and some attach to them only a vague and secondary importance. These believe that yellow fever originates spontaneously in ships; that it is a "nautical, oceanic, or pelagic" malady, and that if means, easier to apply than those above recommended, were adopted to rid ships and harbors of the poison, generated as is alleged and contained in them, there would be an end of it. Since this view has an important bearing on the prevention of yellow fever, the facts in the matter have been examined in Cuba, and the records of the facts respecting other infected localities, and a special report will be found on this subject in Chapter IX.

CHAPTER VII.

"WHAT CAN AND SHOULD BE DONE TO PREVENT THE INTRODUCTION OF THE CAUSE OF YELLOW FEVER INTO THE SHIPPING" AT HAVANA AND OTHER CUBAN PORTS?

What can and what should be done are very different questions. To the former it might be answered, the United States can adopt only one measure to protect itself effectually and with absolute certainty: prohibit the entrance into its ports, during the season when these are endangered, of all vessels cleared from infected ports. The second question might be answered with equal brevity, to the effect that the chief thing which should be done would be to eradicate the disease from Cuban ports; but, in this regard, the United States can do little, if anything.

None the less, there are some things which both can and at the same time should be done, since they tend to greatly diminish the dangers of infection, and these *palliative* measures, which experience and better sanitary organization may render thoroughly effective, will be considered. This consideration will not be strictly limited to the preventing the introduction of the poison at infected ports of departure, but will include reference to some of the means calculated to eradicate the poison after its introduction into vessels, and to prevent such vessels from continuing to be sources of danger to other vessels and to other ports.

A.—GENERAL RECOMMENDATIONS.

The measures which will be first mentioned have been either already referred to or are well known, and therefore require only a brief recapitulation. The ballast, especially at Havana, Matanzas, and Cardenas, should, in our ignorance of the subject of fomites, be regarded with suspicion, as a probable mode of introducing into shipping the cause of yellow fever. Means can and should be adopted to avoid this source of danger; cleaner, denser, less porous and absorbent ballast could be obtained; this could be kept in places less filthy and wet, and farther from the very edge of the harbor, as some of it now is; and ballast might be disinfected.

Since pure water and air are the most plentiful and among the most efficient disinfectants, these should be used in sufficient abundance to maintain in every nook, corner, and crevice of a vessel perfect cleanliness and thorough ventilation—all important ends—which will never be perfectly secured until the naval architect succeeds in constructing vessels which will satisfy hygiene, as well as commerce and war. In urging the use of water with sufficient freedom to secure the thorough cleanliness of the vessel, it is not intended to recommend such abuses of it as would insure a constant and prejudicial humidity of the atmosphere.

Vessels should lie out in the open harbor, as distant from the shore, from centers of population, and from other vessels as may be practicable; and, to the same extent, they should avoid intercourse with the shore, and keep to the windward of infected vessels and localities. Experience in the French Antilles has tended to prove that a vessel anchored from 40 to 65 feet to the windward of an infected vessel is comparatively safe. In this connection it is proper to insist upon the fact, important especially to quarantine officers, that all places, though equally infected, are not equally dangerous to their shipping; that the danger varies, other things being equal, with the size and location of their different harbors; and that those harbors are the most dangerous which force vessels to anchor close to each other, and enable them to approach nearest the shore and centers of population. It is for this reason that the small harbor of Havana, inclosed by crowded dwellings encroaching on the very edge of the shore, is the most dangerous harbor in Cuba, and probably in the world. For like reasons, the harbor of Santiago de Cuba is specially dangerous, and next in order are the harbors of Cienfuegos and Matanzas, while those of Cardenas, Sagua, and most other ports of Cuba subject the shipping to much less risk. The shipping at Vera Cruz also suffers little, and even less at other Mexican ports, for, at these, vessels are forced to anchor far from shore and have abundant space.

B.—DISINFECTION.

Every succeeding year is now likely to increase existing knowledge of disinfectants, and the means to utilize this knowledge in controlling disease. We now know that disinfectants should be used in much greater amount than has been customary, more extensively throughout the ship, and more frequently when the cargo is discharged, when the reloaded vessel is nearly ready for departure, and during the voyage. Ex-

perience seems to prove that an infected ship is even more dangerous than infected persons. On the advantages derivable from the disinfection of vessels, Dr. De Caneda, who, in addition to other official duties already referred to, is health officer of the dockyard of the Spanish navy at Havana, reported to the United States commission, in August, 1879, as follows:

"The royal order of May 10, 1859, decreed that ships of war leaving this port for the peninsula (Spain) shall, before sailing, clean, ventilate, and fumigate all the baggage-rooms and berths—operations which must be frequently repeated during the voyage; that all the quarantine regulations shall be enforced with scrupulous minuteness, under the responsibility of the commander and surgeons of each ship, and shall be practiced with energy and care, even when not exacted by the board of health of the lazaret where the ship may be in quarantine; and, finally, that the clothes of those who die at the dockyard shall be sold there. Since the publication of the above royal order its requirements have been strictly complied with, and during the long period which has intervened (twenty years), and notwithstanding the considerable number of ships of war which have arrived at the peninsula from this dockyard, in none of them has a case of yellow fever appeared."

Dr. Burgess also testified, that "the experience of the Spanish navy has demonstrated the efficiency of this measure, and that, when homeward bound men-of-war, after suffering from yellow fever here, have been thoroughly fumigated just before proceeding to sea, cases of the disease have not afterwards occurred on board."

It should be observed that this royal order makes no restrictions as to season, but that vessels of the Spanish navy are required throughout the year to cleanse, ventilate, and disinfect. Since the poison of yellow fever manifests some activity at Havana during every month of the year, it is a wise precaution to insist that all known means for protection should be continued during even the winter. The annals of medicine record the cases of many vessels which, once infected, have, while sailing around Cape Horn or to the frozen regions of the north, had this infection apparently destroyed —to reappear, however, with renewed activity, on the return of such vessels, even months afterward, to regions of elevated temperature. Hence, as the superabundant poison at Havana sleeps, but only restlessly, during the winter, the vessels there, more numerous and more exposed than at all other ports, should be under constant supervision. Such supervision would not only tend to destroy a poison which later might inflict widespread injury, but it would also tend to accustom vessels to submit to measures imperative throughout not less than five months of every year, to habituate sanitary inspectors to all the details of their important duties, and to promote a better knowledge of the poison through their official records of the sanitary condition and history of all vessels inspected.

While thus referring, in connection with disinfection, to the special need of a sanitary medical officer at Havana throughout the year, it may be well to add that the careful study by such an officer of the few isolated cases of yellow fever which occur during winter would be likely to throw more light on the etiology and prevention of the disease than a like study at other seasons, when the cases become so numerous that it is impossible to trace out, through many confused perplexities, their essential attending circumstances. It should also be remembered that there is no place comparable to Havana for the opportunities presented to try the efficiency of experiments on the disinfection of vessels with cold, steam, hot air, &c.; and that our knowledge of the means to protect vessels would be greatly advanced if an efficient officer, with adequate means, were employed in Havana for this purpose alone.

While the cleansing, ventilation, and disinfection of vessels in Havana, at all seasons of the year, would be a wise precaution, these measures are still more especially required to be applied to those vessels which discharge at wharves or anchor near either an infected shore or vessel, and to those which are destined to the southern ports of the United States. Finally, it should not be forgotten, in reference to the disinfection of shipping, that the number of yellow-fever cases on board a vessel is not an infallible criterion of the extent to which this vessel may be dangerous, and to which it needs disinfection; for vessels have been repeatedly proved to be most dangerous though there had been no sick on board at the port of departure, nor during the voyage, nor on arrival at the port of entry; none immediately suffering except those engaged at the latter port in discharging the cargo. Of many such instances two may be cited. The immediate cause of the royal order to the Spanish navy, above referred to, was the fact that the man-of-war steamer Isabella II sailed from Havana in May 1858, and having first touched at several ports on the southern coast of Spain, finally arrived in September at Ferrol on the north coast, where cases of yellow fever among the crew occurred for the first time. On May 10, 1880, the bark Excelsior, after passing four weeks at Rio de Janeiro, sailed for New Orleans, and arrived at the quarantine (70 miles below the city), on June 24; the vessel remaining there 12 days, and undergoing, as is alleged, disinfection, arrived in New Orleans on July 5, and not until some sixty hours after arrival did the first case of yellow fever appear on this vessel, although the poison had evidently been present during at least the 58

days from May 10 to July 7, without giving any proof of its presence. That the first case was due to poison brought in the ship from Rio was proved by the fact that there was no case of the disease in New Orleans, either prior to, or succeeding the arrival of the Excelsior,* while several other cases quickly followed on this vessel, which had been promptly returned to the quarantine station. This instance forcibly illustrates, among other facts, the necessity of as thorough disinfection of vessels, from infected ports, which neither have nor have had cases of yellow fever on board, as of those which present indisputable evidence of infection.

C.—FOMITES.

France, because of its colonies in the West Indies and on the west coast of Africa, has had a prolonged experience with yellow fever, and no nation has equaled this in the length of time during which it has had an able corps of sanitary medical officers for the inspection of ships and for the study of the means to prevent the importation of this disease. Hence, French experience deserves special respect. France declares by law what merchandise on vessels shall be treated as yellow fever fomites, and in respect to these imposes sanitary precautions in the following order:

First class—most dangerous: "Clothing of all kinds and effects in use, rags of all kinds, skins, feathers, hair, and generally the *débris* of animals, linen and silk materials."

Second class—much less dangerous: "Cotton, flax, and hemp."

Third class—so little dangerous that no special precautions are required: "All objects not included in the above classes."†

It follows that materials of the first class, as also any others to which experience may attach strong suspicion, should be treated with special precautions, not only at the port of entry, but also at the port of departure and during the voyage.

The interests of commerce imperatively require a thorough study of the subjects of fomites, for there can be little doubt that at the present time great pecuniary hardships are at times imposed, by condemning some articles to quarantine which may not deserve it, while others, which may deserve stronger condemnation, are released. Our present ignorance is our only justification for our wholesale suspicions and precautions. It is not probable that science will make much progress in attaining absolute certainty respecting every class of articles, until better disciplined sanitary organization contributes more extensive and accurate observations. None the less, it is believed that our present voluminous yellow fever literature, if thoroughly investigated by a competent student, would yield many facts of practical value on this special subject.

Speaking generally of yellow fever fomites, we are justified in believing that those are the most dangerous which are the most porous, or have the most interstices, whereby air is best confined. Speaking specifically, the following three instances respecting articles not mentioned in the preceding list may prove of interest. At St. Nizaire, in 1861, Mélier subjected to close observation numerous packages of sugar well packed in clean boxes; these came from an intensely infected vessel, and very many susceptible persons were exposed, under apparently most favorable circumstances, to any evil influence these boxes might possess, but not the least evidence of any such influence was manifested. Dr. J. S. West, of Berne, Texas, details facts which led him to the conviction that a sack of coffee from infected Corpus Christi was the cause of a yellow fever epidemic in Liberty, Tex., in 1867; and, farther, that coffee removed from its original sack, and repacked in a number of small parcels, was, in another settlement of Texas, and during the same year, the means of infecting "every family into whose house this coffee was introduced." A very intelligent citizen of New Orleans, a large importer of fruits, testified in January 1879, before the Congressional committees, investigating the great epidemic of 1878, that he had easily succeeded in evading numerous inland quarantines, and had introduced from August 20, to October 1, 1878, while the epidemic was raging in New Orleans, abundance of *bananas* and *cocoanuts* into Saint Louis, Louisville, Cincinnati, Chicago, and India-

* This single case in New Orleans occurred July 7, died the 10th, and to present time, August 27, 1880, no other case has occurred.

† The Louisiana State board of health published, in its regulations for 1880, the following respecting fomites: "For the purpose of sanitary measures, merchandise shall be arranged in three classes. (1) Merchandise to be submitted to an obligatory quarantine, and to purification; (2) merchandise subject to an optional quarantine; (3) merchandise exempt from quarantine. The first class comprises all clothing, personal baggage, and dunnage, paper-rags, hides, skins, feathers, hair, and all other remains of animals, cotton, hemp, woolens, and coffee in bags. The second class comprehends sugar, silk and linen, and cattle. The third class comprehends all merchandise not enumerated in the other two classes."

The State board of health of Tennessee, on July 14, 1880, added to the above "first class," of the articles declared contraband of quarantine by the Louisiana State board of health, the following additional articles, to wit: Second-hand bedding, clothing, upholstered furniture, and textile fabrics; moss, jute, and 'excelsior', tropical fruits and productions." (P. 457, Nat. Bd. Health Bulletin, No. 4, v. 2, July 24, 1880.)

napolis; and, that, as was well known, yellow fever was not thereby introduced into said places. Of course, it does not follow that articles may never have the power to convey infection, because they have not conveyed it on one or more occasions.

D.—NON-INTERCOURSE WITH THE SHORE, AND REMOVAL OF THE SICK FROM VESSELS.

In order to render as absolute as practicable non-intercourse with the shore, acclimated persons should be employed as intermediates between the vessels and the shore, and to do all work needed on board, especially in the hold of the vessel.

To further prevent the introduction and persistence of the cause of yellow fever in the shipping of Havana and other ports, it is very important, however difficult in practice, to exercise supervision and control over all persons, together with their clothing and baggage, on board these vessels while in harbor. Any person sickening with a suspicious disease should be forthwith removed with his bedding and effects to the land, and his apartment with all its contents should be promptly and thoroughly cleansed, ventilated, and disinfected. Persons sick with a suspicious disease should not be admitted on board, nor should those who have been recently sick be received too soon after recovery, nor without special precautions in respect to their effects and their persons.*

Briefly, then, special sanitary precautions, as to the vessel itself and as to all things and persons taken on board, can and should be exercised to prevent the introduction of the poison into vessels at infected points. But while few sanitarians will at the present day question that these precautions should and can be exercised, all will admit that their execution is difficult, and requires the employment of efficient means, and of efficient men to execute them.

E.—REQUISITES FOR THE EXECUTION OF THE MEASURES RECOMMENDED.

Congress enacted a law June 2, 1879, to supply these requirements, and some of the questions involved in this law, and having reference to the duties assigned the United States commission, must be referred to. But brief reference will be made first to a much older law, which has a bearing on the sanitation of vessels, though not enacted for this purpose; and a still briefer reference must also be made to another subject of subordinate interest.

The law just referred to was enacted for and subserves the humane purpose of protecting our sailors from being left destitute in foreign ports. It requires that American vessels shall pay for the benefit of sailors, discharged under certain specified contingencies, "three months' extra wages;" and one of these contingencies is the discharge of a sailor because disabled by sickness. An evil result of this law is that ignorant, inhumane, or avaricious captains, especially of small sailing vessels, not infrequently detain on board, at the risk of infecting vessel and crew, sailors attacked with yellow fever. Further, in cases where the sick sailor has been removed from the vessel, and has recovered, such captains are prone to receive him and his effects on board at an earlier period of convalescence than is prudent, and without exercising proper precautions. It is possible that this evil would be diminished if the law were so amended that captains would not be forced to pay the "three months' extra wages" in cases where a sanitary inspector or a respectable physician certified that the sick sailor's presence on board endangered either the sailor himself, the crew, or the vessel. Also, it is probable that, if it were it required that all cases of suspicious disease occurring or received on a vessel while in harbor should be reported in its "bill of health," and if vessels with such bills of health were treated at the port of entry with exceptional rigor, as they should be, these measures would also tend to rectify the evil. However, the sanitary expert may rest content with calling attention to a legal evil, leaving its rectification to legislative experts.

For the same reason no recommendations are made as to what legal measures should be adopted to secure two very desirable ends—the prompt report to the United States consul of all cases of suspicious disease present on a vessel, and the non-intercourse of persons on board with the shore. In reference to the latter, that able, zealous, and experienced officer, Mr. Henry C. Hall, United States consul-general at Havana, was addressed, and replied as follows:

"In answer to your question, I will say that, as regards this port, nearly all vessels (other than steamers), and especially vessels bringing cargoes and coals, discharge at the wharves, and I can suggest no measure that the United States could adopt, nor that the port authorities could adopt, short of actual confinement, which would tend to prevent the crews of such vessels from visiting the shore; indeed, I do not perceive that anything would be gained by such a measure, for the seamen while lying at the wharves are practically on shore. Vessels lying in the harbor, away

* Férand, in his Yellow Fever at Senegal, p. 392, declares his conviction that "the sick should be kept from the well until at least five days have elapsed since their perfect cure."

from the wharves, are better situated in this respect; but, as a rule, masters of vessels in this port make every effort to keep their men on board, not only to avoid sickness, but to prevent drunkenness and its usual results, insubordination and desertion."

The "act to prevent the introduction of contagious and infectious diseases into the United States," approved June 2, 1779, provides in sections 2, 3, 4, and 5 the means to be adopted to prevent the introduction of any such disease into a vessel at its port of departure, an end of primary importance to the accomplishment of the purpose of the law. Means are prescribed, to obtain information through consuls as to what ports are infected; to force every vessel at such port and bound to the United States to comply with the rules and regulations necessary "to secure the best sanitary condition of such vessel, her cargo, passengers, and crew;" and to provide the most dangerous of these ports with medical men as sanitary inspectors, these officers being indispensable to the efficient execution of the law. The law decrees that it "shall not be lawful" for any vessel to enter into any port of the United States without the prescribed "certificates required to be obtained at the port of departure," and imposes a heavy penalty for any such infraction of the law. The act further provides "that none of the penalties herein imposed shall attach to any vessel, or any owner or officer thereof, till the act and the rules and regulations made in pursuance thereof shall have been officially promulgated for at least ten days in the port from which said vessel sailed."

None will deny that this law indicates great progress in national sanitation, and that its purpose deserves earnest commendation. Whether it trespasses on international rights is a question which concerns experts in such matters. However, it is certain that other nations have thrown obstacles in the way of its execution. In Cuba it was violently denounced by the press, and was referred to with gratification as the cause of "many and sovereign rebuffs" to our country, whose officials, instrumental in making and in executing it, were broadly intimated to be ignoramuses, "ragamuffins," and "insignificant individuals who had succeeded in climbing into public office." Much other ridicule, banter, and defiance was indulged in, none of which would be worthy of mention, except for the fact that the press of Cuba is subjected to official censorship, and can publish nothing without authority.

The action of the authorities in Cuba was as follows: About August 14, 1879, Dr. Burgess received in Havana his appointment as United States sanitary inspector of that port. On August 28 the United States consul-general applied for the permission indispensable to officially promulgate the law, as required by the act; and without which promulgation, as no penalties could be enforced, the act would be inoperative. The permission to promulgate was not granted, and about this time appeared the following order in the Official Gazette:

"OFFICE OF THE MILITARY COMMANDANCY OF MARINE,
"AND OF THE CAPTAIN OF THE PORT OF HAVANA,
"*Health Department, Havana, August* 25, 1879.

"It being very frequently requested by the consignees of vessels carrying more than sixty persons, counting passengers and crew, that their departure shall be allowed with a hospital steward on board instead of a surgeon, under the plea that a surgeon cannot be found; and as it is ordered in the health regulations and royal order of November 28, 1848, that on no account should such vessels be cleared without a physician and chaplain on board, the board of health of this port has decreed the strictest compliance with the above, and in order that commerce and shipping shall not suffer any prejudice or delay therefrom, this order is made known to *whomsoever it may concern*, with the understanding that consignees shall not be allowed to open a register for passengers without complying with the prescribed regulations.

"At the same time those physicians who desire or whom it may suit to utilize their knowledge among the shipping may call at this office during business hours, and leave their names and addresses, in order to be advised in case their services are required.

"MANUEL DELGADO."

As to whom this order may concern, the Boletin Commercial of September 6 announced: "As our maritime authorities are determined to strictly enforce this order, we publish it to-day, so that it may be made known to the consignees, owners, and captains of *all* vessels plying between *any foreign* and this port."

The following order, of much greater consequence than the preceding, issued from headquarters, and was published on August 30, 1879, for the first time in the Official Gazette:

"HEALTH-CIRCULAR.

"His excellency the governor-general being informed, by different communications presented to him by the health department of the port of Havana, of the practice, observed by some consuls residing in this city, of issuing bills of health to national as

well as to foreign vessels leaving the said port—in contravention of the laws upon the subject in force in this island, and thus causing injury to the public revenue, his excellency has been pleased to order that it be made known by means of the present circular to the said consuls that, it being provided that the documents referred to shall be issued solely and exclusively by the Spanish employés in charge of this branch of the public administration, they shall restrict themselves to certifying upon the said bills of health the authenticity of the signatures authorizing the bills of health, and their own opinion in regard to the sanitary conditions therein set forth.

"Which, by order of his excellency, is published in the Official Gazette for general information.

"Havana, August 27, 1879.

"*The Secretary of the General Government,*
"JOAQUIN CARBONELL."

It is noteworthy that the United States consul-general applied for permission to promulgate the law of the United States on August 28, and that although the above-quoted order is dated August 27, it was not published "for general information," nor otherwise made known to the officers of the United States, until August 30. It is also noteworthy that both of these official documents should base their justification on obsolete, forgotten laws, which were revived at the very time when efforts were first made to execute the law of the United States. For the purpose of aiding the interpretation to be given the latter order, it may be added that on September 6, 1879, the following telegram was received by the United States consul-general at Havana:

"MATANZAS, *September* 5, 1879.

"The captain of the port of Mantazas refuses to clear an American vessel unless she takes a Spanish bill of health.

"WASHINGTON,
"*United States Vice-Consul at Matanzas.*"

An ineffectual protest was made.

After August 30 the Spanish steamship *Castilla* left Havana for New York without the "certificates required to be obtained at the port of departure," and for this infraction of the law the penalty decreed was not enforced at the port of entry.

Such is the brief history of the overthrow of this law at both ends of the line—a law so important that if its provisions are not to be enforced it seems idle to discuss the question, "What can and should be done to prevent the introduction of the cause of yellow fever into the shipping at Havana, Matanzas, and other Cuban ports?" For, nothing of any consequence will ever be done except under the supervision of officials whom the United States can hold directly responsible for the enforcement of "such rules and regulations" made by its authority as may prove necessary "to secure the best sanitary condition of a vessel (at an infected port), her cargo, passengers, and crew." Bills of health should be not merely idle and even deceptive formalities, but ample proof of what they purport to be. This can never be assured at any infected port of departure, except through officers who are not only stimulated by self-interest to protect the welfare of the port of entry, but who are also competent to determine the conditions necessary to insure that a departing vessel is really "clean" and free from danger to others. To the sanitarian it is a deplorable farce that commerce should be burdened with such "clean bills of health" as the Cuban authorities at Havana issued after October 4, 1879—a date when there had been not less than twenty deaths by yellow fever during the week, and when there were eighty cases in existence on that very day, and nine vessels in the harbor manifestly infected.

It remains to be seen whether the Congress of the United States will, in reference to its violated law, lend its ear to the alleged interests of commerce solely, or to the inseparable interests both of commerce and of the public health; whether having taken a notably forward step in sanitary progress it will falter, or will advance firmly, even if slowly and cautiously.

In this connection it is pertinent to recall the historical fact that while the authorities in Cuba interfered in 1879 with the execution of the sanitary and quarantine laws of the United States, it is only a few years since the sanitary laws of the former proved equally obnoxious to the latter, and were enforced against it most objectionably. In July, 1866, the governor-general of Cuba, "consequent upon the information transmitted to his excellency by the Spanish consul in Philadelphia, of cholera having appeared in that city," "declared foul *all the ports* of the United States, and decreed that all vessels arriving from them at the ports of Cuba should be subjected to the most rigorous quarantine." Accordingly they were so subjected for twenty days, and without regard, to clean bills of health countersigned by Spanish consuls in ports of the United States, to the port from whence they came, to the date of their departure, to the length of the voyage, "or to any other consideration whatever." Moreover, the quarantine for the whole island was established July 4, 1866, on the

north coast, twenty-five miles west of Havana, at the port of Mariel, and all American vessels bound to any Cuban port were forced to proceed to Mariel, though this might be, as in the case of Santiago de Cuba, nearly a thousand miles from their port of destination. The United States Commission has a list of forty-nine American vessels, which, during solely the six weeks, August 15 to September 29, 1866, were thus forced into quarantine at Mariel.

In view of the facts now presented of the causes which have given rise to mutual complaints, and of the doubts which have sprung up, not as to the wisdom of the theory, but as to the practicability and international legality of the law of June 2, 1879, it becomes an important question whether the humane and laudable objects of this law will not require for their realization a conference of all maritime civilized nations, in order to establish an international sanitary code for their mutual protection. So far as Cuba alone is concerned, table No. 2 and the note following table No. 1 show to what large extent the vessels of other nations are involved in the execution of our law, and that while Spain and Great Britain are chiefly interested in behalf of their shipping, the vessels of not less than ten other nations sailed during one year from the ports of Cuba to those of the United States.

Such a conference and such a code are not without precedent. France, which has in many good things been the leader of civilization, summoned a conference in 1851 of the maritime nations of Europe; medical and consular representatives assembled from twelve of these, including Spain, and Egypt as a dependency of Turkey, and on May 27, 1853, an international sanitary code or treaty was agreed upon.

Since each maritime nation is seriously affected by the sanitary regulations and other restrictions at the ports of all other nations, it is important that these restrictions should be made as little burdensome to commerce and as *uniform* as is practicable. This cannot be accomplished without agreement between the nations interested. The experience of the last summer in regard to the execution of the law of June 2, 1879, makes it manifest that one nation cannot exercise within the limits of another even such sanitary supervision over vessels proceeding from the latter to the former, and as is indispensable for the protection of the former, without giving offense. Spain in 1879 interfered, in connection with yellow fever, with the execution of the law of the United States; but how long will it be before offense is given to other nations in connection with cholera, plague, or other transmissible disease prevailing at their ports, and thereby threatening our own? The interests of sanitation are those of humanity and of civilization, and the advancement of these interests should be through the paths of peace, through mutual concessions and enlightened co-operation.

For these and other reasons, it is believed that the United States, one of the chief maritime powers of the world, and the one whose extensive coast most exposes it to invasion by disease, cannot at too early a date strive to secure an international sanitary code.

Advocates of this measure can derive important instruction from the international sanitary regulations of 1853, which have been referred to. Certain general principles were agreed upon, such as that no nation should be guilty of the inhumanity of prohibiting a vessel in distress, whatever else might be its condition, from entering any port; and such as, that in all cases of doubt as to the execution of any of the details concurred in, the benefit of that doubt should be construed in favor of the public health rather than in favor of the immediate interests of commerce and gain. In addition, *uniform* regulations were established in reference to numerous details, which concern the following four principal subjects: first, some degree of uniformity and efficiency in the organization of sanitary authorities at seaports; second, regulations as to vessels arrived at a port of entry, including the establishment of quarantine, lazarets, &c.; third, regulations to be observed on vessels during their voyage, including the penalties to be enforced at ports of entry for their non-observance; fourth, rules and regulations as to vessels at ports of departure, devised to prevent the introduction of transmissible diseases into these vessels. Only the last subject will be further considered, since it alone falls within the official instructions to the United States Commission.

In regard to the port of departure, it was agreed that official reports should be regularly furnished, by the sanitary authorities of the place, of its true sanitary condition, including the appearance and disappearance of transmissible diseases; that the hygienic condition of every vessel, its cargo, crew, passengers, and provisions of water and food to supply these, should be inspected and certified to; that the vessel should be inspected in all its parts, not only before loading, but also after this, to see that orders issued in reference to cleansing, ventilation, and disinfection had been obeyed, and that all things needful to maintain health on board had been provided; that those sick of transmissible disease should be prohibited from going on board; that captains should be required to furnish sanitary inspectors with all necessary information and aid; that vessels of foreign nations should be visited in company with their consuls; and, finally, that a uniform bill of health should be adopted, which should in every

case be either "clean" or "foul," and should be invalid unless issued within forty-eight hours before the vessel's departure. Such are the principal details which the thirteen contracting nations deemed it important to agree upon for the purpose of preventing the introduction of transmissible diseases into the shipping at ports of departure.

But in connection with this report, further instruction is derived from these international regulations in respect to the nationality of the officials by whom the above details were to be supervised and enforced. These duties were intrusted to the local officials at the port of departure, except in the ports of the Orient. So great was the fear of the plague and of cholera that special provisions were agreed to, in 1853, as to Turkey and Egypt, although, as early as April, 1847, France had dispatched to the Levant its own sanitary inspectors. It was agreed that the contracting nations should station in the Orient a certain number of sanitary physicians, and that their distribution should be allotted between, and be regulated by these nations. Although ordered to cultivate friendly relations with the people and officials of the country, each was made responsible to his own government alone; and, though subjected to the jurisdiction of his own consul, each was rendered totally independent even of him in the discharge of his medical duties. The sanitary officer was invested with all power requisite to protect his own country and to aid in securing the safety of all the contracting parties. It thus appears that in Europe it was deemed necessary, in 1853, to obtain the consent of Turkey that foreign nations should appoint sanitary inspectors to discharge their appropriate duties within its jurisdiction.

One additional topic of interest remains to be noticed. Article 137, Title X, of the International Sanitary Regulations contains the following:

"DISPOSITIONS RELATIVE TO AMERICA."

"In the countries subject to yellow fever, and which belong to the contracting parties, and where a regular medical service has not yet been established, there shall be appointed, by the respective governments, sanitary physicians to study this disease, its mode of production and propagation, to seek the means of preventing and combating it, to notify its appearance and disappearance to the authorities, and, in fine, to fulfill officially, in respect to yellow fever, the mission with which the sanitary physicians in the Orient are charged in regard to the plague."

Finally, the facts of chief importance having now been stated, this commission deduces therefrom the following conclusions in reference to the question propounded by the National Board of Health and now under consideration. Certain palliative measures which have been specified can and should be adopted. The execution of those measures depends upon the rigid enforcement in the ports of Cuba, and especially in Havana, of such provisions as are contained in the act of June 2, 1879. The effectual enforcement of this act requires the consent and aid of Spain at least, and since all maritime nations are interested in the execution of this act, an international sanitary code is most desirable for the establishment of such uniform rules and regulations as the general interests of national sanitation require for many purposes, as well as for the special purpose of preventing the introduction of transmissible diseases into the shipping at infected ports of departure.

E.—EVIDENCES OF SANITARY PROGRESS SINCE DECEMBER 1879, WHEN THE PRELIMINARY REPORT WAS PUBLISHED.

The United States National Board of Health and its Havana Yellow Fever Commission have good reason to claim that the following four acts, which form an appropriate addition to the preceding recommendations published in December 1879, were due in great degree to their influence.

First. On June 19, 1880, the National Board of Health published certain additions to and improvements of previous regulations, so that these now read, in reference to the present subject, as follows:

"*Rules and regulations for securing the best sanitary condition of vessels, including their cargoes, passengers, and crews, coming to the United States from any foreign port where any contagious or infectious disease exists.*

"To secure the 'best sanitary condition' of a vessel the following points should be observed by the owners, agents, or master of such vessel:

"A. Exclusion from the vessel, as far as possible, of persons or things known or suspected to be infected.

"B. Cleanliness, dryness, and ventilation of the vessel, both preliminary to loading and during the voyage.

"C. Disinfection; that is, the destruction or removal of the causes of disease, which include measures of cleanliness, ventilation, fumigation, &c.

"D. The crew shall not be allowed liberty on shore after nightfall in suspected localities. They shall not be allowed to sleep on deck except under awnings. The forecastle shall be well ventilated and kept dry. Both in port and at sea the bilge water shall be pumped out each morning and evening, or more frequently if necessary. The utmost cleanliness shall be observed at sea as well as in port. Each seaman should have two suits of under-clothing. The clothing and bedding should be aired every clear day. In tropical climates the men should be required to wash their persons and change their under-clothing every evening after work while in port, and each working suit should be washed, dried, and aired after a day's use. These regulations, as to clothing, airing of bedding, and ventilation, should, as far as possible, be observed at sea as well as in port."

Farther: "Every vessel before taking on cargo or passengers shall be clean and dry, and the certifying officer may, at his discretion, require that it shall be thoroughly disinfected, if last from an infected port, or if the port of departure itself be infected. The examination of the vessel as to cleanliness shall be made before the cargo is taken on, and shall extend to all accessible parts, especial care being taken to note upon the bill of health the presence of decayed wood.

"Earth and porous stone shall not be used for ballast if avoidable.

"Merchandise or articles known to be infected shall not be received or taken on board.

"In case the port is infected, the certifying authority may require that the officers, crew, and passengers shall be examined by a medical officer or physician selected for that purpose, and the result of such examination reported to him not more than twenty-four hours before certifying to the bill of health."

Second.

[PUBLIC RESOLUTION—No. 26.]

JOINT RESOLUTION authorizing the President of the United States to call an international sanitary conference to meet at Washington, District of Columbia.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the President of the United States is hereby authorized to call an international sanitary conference to meet at Washington, District of Columbia, to which the several powers having jurisdiction of ports likely to be infected with yellow fever or cholera shall be invited to send delegates, properly authorized, for the purpose of securing an international system of notification as to the actual sanitary condition of ports and places under the jurisdiction of such powers and of vessels sailing therefrom.

Approved, May 14, 1880.

In compliance with this resolution, action was taken July 30th, 1880, by the Secretary of State, to hold the proposed conference at Washington January 1, 1881.

Third. On March 10, 1880, the governor general of Cuba established by decree the following:

"NEW SANITARY REGULATIONS.

"1st. All vessels at any port of this island where a sanitary board exists shall report the same as soon as discharged in order to be inspected.

"2d. Before proceeding to load or take ballast, the captain or mate must present a certificate of the sanitary board, stating that *she has been inspected and is in proper condition for loading.*

"3d. After all the cargo is on board the captain shall again report to the same board, so that the vessel be newly inspected, in order to ascertain whether the indications previously made by the doctors have been duly attended to by the captain.

"4th. The doctors in their visits shall particularly examine the general sanitary condition of the vessel in all her departments, including the hull, between decks, steerage, engine, kitchen, stove, pantry, berths, infirmary, water-closets, medicine supply, water, and provisions.

"5th. They will also be careful, when any vessel has terminated loading and is ready to leave, that there be on board none actually attacked by or recovering from yellow fever; that the number of passengers and crew be in relation with her capacity, as marked in the general sanitary regulations; that there be a sufficient supply of medicines, water, and provisions, all in good condition, so as to ensure the health of all parties on board.

"6th. Whenever the doctors deem that the vessel should be fumigated, they will give the captain a written order explaining the way this is to be done, as well as when they deem it necessary to open new ports, or place hoses, or introduce any other innovation in the vessel.

"7th. Doctors shall communicate by writing all their orders and indications to captains and mates of vessels, who, in their turn, shall give a written receipt for the same.

"8th. The above rules are applied without exception to all the establishments of whatever kind and nature, such as warehouses, stores, hospitals, &c., &c., either civil or military, in order to lessen as much as possible the causes of the epidemic disease prevailing here every summer."

Fourth. The following important order was issued by the governor-general of Cuba June 18, 1880:

"HEALTH CIRCULAR.

"In consequence of doubts having arisen with port physicians in regard to whether it is or is not obligatory upon all vessels, leaving the island of Cuba, to take bills of health, his excellency the governor-general, in conformity with the suggestion of the superior board of health, has been pleased to order that national as well as foreign vessels *are free to take out or not* the said bills of health, except when bound to Spanish ports, in which case they shall provide themselves with the document referred to. Which, by order of his excellency, I communicate for your information and compliance, and for publication in the official bulletin of the province under your worthy command.

"God preserve you many years.

"JOAQUIN CARBONELL,
"*Secretary of the General Government.*

"HAVANA, *June* 18, 1880.
"To the CIVIL GOVERNOR OF THE PROVINCE OF ———."

It will be observed that this order contrasts in a most gratifying manner with the orders of August 25 and August 27, 1879, published on a preceding page. These seemed to be narrow, intolerant, and most objectionable, while the order of June 18 is worthy of a liberal nation, and removes causes for irritation, in that, needless impediments are no longer placed in the way of the United States sanitary inspector in discharging duties of great importance to his own country, of advantage to all others, and of injury to none.

The present chapter terminates the consideretion of all the topics presented in the preliminary report, except the topic of the alleged spontaneous origin of yellow fever on ships, and the consideration of this has been deferred to the ninth chapter. It may be concluded by some that the eighth and tenth chapters trench upon the domain of theory to greater extent than may be appropriate to a report dedicated to a record of facts and not of opinions; but when a special subject is embarrassed with a multitude of contradictory statements and of apparently contradictory facts, it is believed that the bare record of these would prove of little service, and that efforts, as little theoretical as existing knowledge permits, to reconcile contradictions, are calculated to prove more interesting and instructive, and are therefore justifiable. In these quasi-theoretical chapters the same strenuous effort has been made, as elsewhere in this report, to record all the evidence and the facts, and to deduce no conclusions not justified by these.

CHAPTER VIII.

THE ORIGIN AND SOME PROPERTIES OF THE POISON OF YELLOW FEVER, AND OF OTHER SPECIFIC SPREADING DISEASES.

"The dominant mind of Aristotle [350 B. C.] stamped its notions on the world at large. For nearly twenty centuries after him men found no difficulty in believing in cases of spontaneous generation, which would now be regarded as monstrous by the most fanatical supporter of the doctrine. Shell-fish of all kinds were considered to be without parental origin; eels were supposed to spring spontaneously from the fat ooze of the Nile: caterpillars were the spontaneous products of the leaves on which they fed, while winged insects, serpents, rats, and mice were all thought capable of being generated without sexual intervention." (Tyndall.) The influence of these ideas was so great that it is only a few generations since a high court legitimized a child on the ground that the mother, separated four years from her husband, had been impregnated by a dream!

But in nothing has this influence been more marked than in the views advocated respecting the causation of epidemic diseases. There is not one of these the origin of which has not been attributed to such cause as "hell itself breathes out contagion to this world," "spasmodic convulsions of the sickened earth," air corrupted by the aggregation of many races, malign influences of the sun, moon, stars, comets, earthquakes, volcanoes, tornadoes, inundations, "cosmo-telluric" influences, putrid emanations, &c., &c. Not until Frascator's work, in 1550, was the modern idea of contagion taught. The spontaneous origin of hydrophobia was long obstinately advocated. Even small-pox was assigned a *de novo* origin in such causes as those above mentioned until early in the eighteenth century, when Boerhave first established that it was never due to spon-

taneous development, but always to a specific contagious poison. The same fact was not established as to measles until the middle of the eighteenth century; and cases of the spontaneous origin of scarlatina, though it never reached North America until 1735, nor South America until 1829, are still occasionally claimed to occur. It is less than thirty years since Budd denied the spontaneous origin of typhoid fever, an origin still contended for by some. In fine, modern research has tended constantly to prove that diseases, above all, migratory epidemic diseases, have no such origin; and the spontaneous-generation experiments and the whole tendency of modern science are opposed to any such belief. None the less, "indigenous," "spontaneous," "*de novo*" origin and development are words incessantly repeated in the present literature of yellow fever, and express ideas firmly entertained by many, especially by those who reside in habitually infected places—the worst of all places in which to solve such a question.

There are three chief causes for the belief in the spontaneous origin of yellow fever. Some, more deeply impressed by past than by recent knowledge, are not able to understand that a disease may not be personally contagious, in the manner of small-pox, measles, etc., and yet may be portable and communicable, as are trichina, tape-worm, typhoid fever, and cholera. A second cause is the very old one of mistaking those causes which favor the propagation of a poison for those which originate it. Finally, disbelief in the duration of the dormant vitality of disease-poison is a constant source of error. Correct views in respect to these matters are of great moment in practical sanitation, and some of the points involved will receive brief consideration.

The poison of yellow fever must be, on the one hand either an inorganic or dead organic something, or on the other hand a living organism. Very few, if any, even of those who credit its spontaneous origin, deny that this poison has reproductive power. The function of reproduction is limited to living organisms, and such must be the nature of the poison of yellow fever. This conclusion is inevitable unless it can be proved either that the poison has not the power of self-multiplication or that other than living organisms have this power; and until at least one of these improbable hypotheses is proved to be true, science is justified in both thinking and acting upon the above conclusion.* Those who demur to this conclusion demand ocular evidence of the organism, evidence which, though most desirable, is no more necessary to justify a conclusion than chemical or microscopic evidence that the poison is an inorganic, or a dead organic substance.

Sir Henry Holland teaches: "Locke says, in all the corporeal world we see no chasms or gaps. Our actual knowledge proves such gradations in the minute forms of life, that, to suppose other extra-microscopic forms do not exist implies a breach of continuity not justified in the scale of life. Only of late, a new world has been opened by the microscope, before which innumerable forms of life, now visible, were invisible.

A belief in the existence of living organisms, invisible to the highest powers attained or attainable by the microscope, is just as logical as is the universal belief in extra microscopic atoms and molecules. Living protoplasm is composed of atoms and molecules, and the chemical constituents of protoplasm are approximatively well known; hence, if the size of atoms and molecules, and if the least number of these indispensable to form an independent living organism were known, it would be possible to determine how small may be the minutest organisms. While science is still unprepared to answer with accuracy any such question, it none the less has reached, through reasonable hypotheses, approximative conclusions which deserve to be better known. Since Sir William Thompson's effort to determine the probable "size of atoms" (Nature, March 31, 1870), numerous other researches have been made on the subject, all tending to prove the almost inconceivable minuteness of atoms and molecules. The results of these researches, so far as they concern the present subject, have been instructively summarized by one of the very highest authorities in this matter, namely, by H. C. Sorby, F. R. S., &c., in his anniversary address, as president of the Royal Microscopical Society, on the "relation between the limit of the powers of the microscope and the ultimate molecules of matter" (Nature, February 24, 1876). He declares that "the *theoretical* limit of distinct visibility" is $\frac{1}{80000}$ part of an inch, and that the perfected microscope of the present day has *practically* reached this limit (some claim that even $\frac{1}{100000}$ of an inch has been reached), so that no further improvement in this direction can be hoped for. Properly emphasizing the fact, that all calculations respecting the size of atoms and molecules are, within certain limits, hypothetical, Professor Sorby, none the less says, "we must conclude that in the length of $\frac{1}{80000}$ of an inch (the smallest interval that could be distinctly seen with the microscope) there would be about 2,000 molecules of liquid water lying end to end, or about 520 of albumen. Hence in order to see the ultimate constitution of organic bodies, it would be necessary to use a magnifying power of from 500 to 2,000 times

* The total failure of inorganic chemistry and toxicology to furnish any invisible poison analogous in its modes of action to the poisons of migratory spreading diseases is well known, as is also the failure of organic chemistry to furnish any substance which, destitute of life, has the power of self-multiplication. Yet, says Lister, it is *conceivable* that there may exist and may yet be found a non-living substance acting on a resolvable substance in such manner that one of the substances resolved should itself be the resolvent.

greater than those we now possess. These, however, for reasons already given, would be of no use unless the waves of light were some $\frac{1}{1000}$ part of the length they are, and our eyes and instruments correspondingly perfect. It will thus be seen that, even with our highest and best powers, we are about as far from seeing the ultimate structure of organic bodies as the naked eye is from seeing the smallest objects which our microscopes now reveal to us. As an illustration, I have calculated that with our highest powers we are as far from seeing the ultimate molecules of organic substances as we should be from seeing the contents of a newspaper with the naked eye at the distance of a third of a mile; the larger and smaller types corresponding to the larger and smaller molecules of the organic and inorganic constituents." Further, "calculating then, from the various data given above (omitted in these citations), we may conclude that a spherical particle *one-tenth the diameter* of the smallest speck that could be clearly defined with our best and highest powers might nevertheless contain *no less than one million* structural molecules." Finally, Professer Sorby says: "For the sake of argument I assume that gemmules (a term used in Darwin's theory of pangenesis), on an average contain one million structural molecules of albumen and molecularly combined water. Variations in number, composition, and arrangement would then admit of an almost infinite variety of characters. On this supposition it would require *a thousand gemmules* to be massed together into a sphere in order to form a speck just distinctly visible with our highest and best magnifying powers."

Dr. G. W. Royston Pigott asserts, in a paper on "Microscopical Researches in High Power Definition," pp. 260–278, No. 208, v. xxxi, Procdgs. of The Royal Society, Dec., 1880, that under certain conditions, which he specifies, the microscope may disclose some particles "less than the millionth," and some filiments $\frac{1}{1500000}$ of an inch in diameter. But, even this assertion, if true, justifies those who have been students of the phenomena dependent on the so-called "infinite divisibility of matter," and who are, at the same time, familiar with such facts as those now submitted, in condemning as an ignorant prejudice the view that there cannot be any living organism too minute for disclosure by the microscope.

It has been wisely taught that the true test of the presence of a living organism is, not the microscope, but that, "when sown, it produces an organism," and "the subsidence experiments" of Pasteur and Tyndall, as also the "sunbeam experiments" of the latter, have conclusively demonstrated the presence in both air and liquids of extra-microscopic particles, which, when sown, germinated. It is manifest that the failure of the microscope to prove that the causes of yellow fever, as also of typhoid fever, cholera, &c., are living organisms, no more disproves this than the failure of all the appliances of science to prove that the cause is an inorganic or a dead substance disproves this conclusion; and the mystery as to what is, in truth, the poison, is increased by supposing it an unknown inorganic something, rather than an unknown extra-microscopic organism. Should conclusive proof of the latter ever be secured it would become only an additional illustration of nature's great law, the destruction of living beings, one by another.

Discarding all opposing views, it remains certain that the route to the unknown is through that which is known; and, granting our ignorance of the poison of yellow fever, we are justified in seeking analogies for it in the known properties, either of any other spreading disease-poisons, or of objects allied thereto.

These poisons are markedly characterized by one of the most striking differences between living organisms and inorganic or dead matter, viz, by the fact that their growth and reproduction occur only under special circumstances. They have either climatic limits, or are greatly influenced by climate; they are, at one time, narrowly localized, at another widely radiated; and they repeatedly refuse to propagate under circumstances apparently identical with those under which they have, on other occasions, best flourished. All the spreading disease-poisons seem to grow best in decaying, putrefying substances, one of the most noted traits of the fungi; and in the peculiarity of the circumstances required for the propagation of these is also found the best analogy to the often inexplicable appearance and disappearance of disease-poisons.

Microscopic fungi are now known to produce a large number of diseases, such as "potato-rot" in vegetables and pébrine in animals; and experts in cryptogamic botany teach numerous facts apposite to the present subject. They are "nature's scavengers," and "are distinguished for their diffusion, number, poisonous properties, minuteness of their spores, and for their love of darkness, tainted soils, and heavy atmospheres." There are still a number of them, which, though often seen flourishing, and though the surrounding conditions on which this depends are open to observation, have defied numerous, prolonged, and most careful attempts to solve the mystery of their germination and cultivation. Experiments, imitating all the apparent conditions under which they are seen to flourish, are not followed by success, thus demonstrating that their growth depends on some curious unknown conditions associated with known conditions. The great majority of them flourish chiefly at the end of summer and in autumn; some grow best in air, others when deprived of it; some require light, others

darkness; many will germinate only in a humid atmosphere, others must float on water, and some must be immersed in it; some will germinate only in such dark, damp, confined places as the holds of ships; some require such peculiar local conditions as immersion in a special fluid, for instance, dying in water but flourishing in orange-juice; some grow only in rotten wood, while others require the bark and leaves of living trees, even of some special tree; some must have a dung-hill, and others an old damp carpet; in one a crop can only be secured by the passage of the spores through the intestines of a horse, and their growth in the expelled excrement; some have appeared in places wholly excluded from the external air, others in inorganic and poisonous solutions supposed to be destructive to vegetable life (Cooke & Berkely), and so on, through an infinite diversity of very peculiar local conditions.

Fungi are very prone to shift their localities, at times disappearing from places where they once flourished. Within the last ten years one, the "puccinia malvacearum," was imported from Australia to England, and in 1874 it was spreading so violently that it was feared hollyhocks would be exterminated. No one knows how or when it was imported, but since Australia was known to be its habitat no one has supposed that it originated *de novo* in England. Fungi have three additional peculiarities worth noting. Some "have in a high degree the curious property of destroying their own reproductive powers, or of poisoning against themselves the soil in which they grow," and thus serve to account for their sudden disappearance after years of prevalence, and for their subsequent reappearance. "Some, which are generally eaten with safety, become through the influence of climate poisonous, and some of the poisonous kinds become esculent." Some are alleged to be poisonous when developed at night, but hurtless if developed by day; and at times the poisonous principle is so volatile and fugacious that drying, boiling, or macerating the fungus in weak solutions causes its poison to disappear. Further, "recent investigations tend to confirm the distinct specific characters of the species found on different plants, and to prove that the parasite of one host will not vegetate on another, however closely allied." Since this is true of the parasites which attack animals as well as vegetables, it is possible that a special parasite might be, as is yellow fever, more partial to man than to inferior animals, and more partial to a white than to a black man.* An additional fact concerning the lowest microscopic organisms, and of interest in the present connection, is recorded by Dr. W. W. Cheyne, who says (p. 124, British Medical Journal, July 24, 1880,) "I have demonstrated that, though many forms of organisms will not survive if introduced into a healthy animal, yet if an animal be previously in a state of ill health, these forms of organisms are not destroyed, but may be found alive in the blood or tissue." Finally, as to vegetable parasites, the following two facts have a bearing on the problems of yellow fever. Pasteur, Greenfield, Buchner, and others have proved that the most virulent germ-poisons can be so cultivated, especially by free exposure to oxygen, that their virulent properties can be "attenuated" or rendered even innocent, and *vice versa*. And, since some vegetable ferments, such as the microscopic mycoderma aceti, give rise to different products which vary with the different conditions to which they, in their growth, may be subjected, it is not improbable that some diseases may be caused, not primarily by the organism itself, but secondarily by its products, even by some special product, which is developed only when the organism is subjected to the peculiar conditions requisite for this special product.

It is worthy of note that a number of animal parasites are now known which pass through several stages of development, each stage requiring its own special and peculiar favorable conditions, and that in only one of these stages does it cause disease. Bots in the horse are parasites only in the larval, and not in the pupal nor in the matured stage. The larvae of the tape-worm infest certain animals, and must be eaten by other animals to develop into maturity. The egg of the thorn headed worm of the hog develops in a crab; this must be eaten by a fish, and this by a hog, to gain the stage of maturity. The "rot" in sheep is due to the fluke-worm, the eggs of which require, for their first stage of development, that they should be eaten by a fresh-water snail. In all instances the undeveloped eggs are harmless. It is also noteworthy that the periodical occurrence of yellow fever, says Reynolds' System of Medicine, "has its parallel in a fact well known to the students of the diatomaceæ and dermidiaceæ, namely, that particular species, which are known to exist in a definite pond or pool one season, may at another season be replaced by forms never before detected in the same spot, while again the original species, under favorable and often unaccountable circumstances, reappear after the lapse of a certain time."†

Preceding facts have not been presented, nor are they claimed, to prove that the

* Koch reported in 1878 that the bacillus septicemiæ, so fatal to the house-mouse, had no effect on the very closely allied field-mouse.

† Greissinger proffers the following truth, and pregnant warning: "A series of years often pass during which yellow fever is scarcely observable in the very places it specially frequents; and this, though there may be no difference in the going and coming of unacclimated strangers. Then there is rejoicing over the presumed disappearance and destruction of the disease, and a triumph of sanitary police over it is often claimed."

poison of yellow fever is a parasite; but, to show that some of the mysterious phenomena of the unknown and invisible poison of yellow fever have their counterparts in similar phenomena of known and visible living organisms; to point out how peculiar may be the local conditions requisite to their growth; and to prove that our ignorance as to these phenomena and conditions in the one, which is unknown and invisible, is no greater than in the other, though well known, very visible, and subjected to circumstances much more favorable for elucidation by scientific research. Such facts enable us better to understand, among other things, why the poison of yellow fever should much more frequently fail, than it succeeds, to propagate when imported; the success or failure depending on some perhaps most trifling, though disastrous contingency. The failures, difficulties, and successes attending the domestication of numerous vegetables, animals, and disease-poisons, when transplanted to foreign localities, is well known, and this view of the poison of yellow fever better accords with present knowledge than the view which assigns it a spontaneous origin. In fine, Dr. Alf. Carpenter well observes, "there is nothing more curious or out of the way in the rise and fall of epidemics than there is in the abundance or scarcity of certain forms of vegetable life, according as the season is dry or moist, or hot or cold, and according as the material required for its nourishment is abundant or the contrary" (Br. Mdl. Journl., Oct., 1879).

Since success in the execution of sanitary measures largely depends on the unanimity with which they are advocated, it becomes an important duty to strive to throw light on every difference of opinion which leads to difference of sanitary practice. One of the most important issues respecting yellow fever is its true relationship to local conditions; whether both the origin and the propagation, or only the propagation of the poison, depend on these? In addition to reasons already stated against such an origin, it seems incredible that any migratory disease can thus originate; incredible that the local conditions of, for instance, Natchez in 1878 should fail to originate that which the local conditions of towns adjacent to and encircling it did, as is claimed, readily and abundantly originate. There is no such difficulty in crediting that the presence or absence of the disease depends primarily on the importation of its poison, and secondarily, on the presence of such local conditions as may be necessary for its propagation. The chief obstacles to this belief are, the frequent inability to prove importation, and disbelief in the power of resistance and in the dormant vitality of the poison. Evidences of the presence of the poison having disappeared for weeks, months or years, it is deemed improbable, even impossible by many, that the poison should still be present, only awaiting favorable local conditions for its reproduction. Hence, on reappearance of the disease, those thus incredulous deem it manifest that the poison must, in the absence of proof of its reimportation, have had a local origin. Now, it is important to remember that this absence of proof is negative evidence, of which no amount can countervail one single instance of positive proof, and that this absence of proof occurs most frequently in the largest and most frequently infected cities, such as Havana, Vera Cruz, and New Orleans. But, the larger a city, the greater and more complicated is its intercourse, and this condition necessarily increases the difficulty of determining the time when, and the mode by which, even large and familiar objects are imported or exported, much more of an invisible and inappreciable poison. Every inhabitant of a small village may easily know when and how an unusual bunch of bananas was introduced, while such a circumstance in a large city would be known to very few, and, if the fruit proved poisonous, would be probably confined to these few. Hence, the introduction of a disease-poison, as of yellow fever, into a small village, is generally more easily traced, though its physicians may have no experience in the disease, than in a large city, however experienced its physicians. Though this seems a self-evident truth, none the less, many have been and continue to be misled by the fallacy, in a matter of this nature, that those who have had most experience in the disease were the best judges, and that their failure to prove importation deserves more consideration than the alleged proof to the contrary, of the inexperienced; however, evidence of the inexperienced, taken under most favorable conditions, is often entitled to far more weight than the evidence of the most experienced taken under unfavorable conditions. But, if all these objections to absence of proof be thrust aside as valueless, the conclusion arrived at, that a reimportation of poison is necessary to account for every reoccurrence of the disease, is not supported by our present knowledge of disease-poisons; for, as will now be shown, this knowledge fully justifies us in believing that the poison of yellow fever possesses, like other disease-poisons, great powers of resistance to time, and to other destructive influences.

Prior to the consideration of this subject, as it concerns disease-poisons, whether known or as yet unknown to consist of living organisms, some suggestive facts respecting organisms, which are not necessarily associated with disease, at least of man, will be mentioned.

The prolonged duration of the dormant vitality of seeds is well known, and is illustrated by the familiar and extreme instance of the growth during this century of wheat

obtained from an Egyptian mummy buried many hundreds of years ago.* Sir Henry Holland teaches that "there is reason to presume, upon various evidence, that the simpler and more minute the form of organization, the greater the faculty of retaining life in a dormant state." He states, that since completely organized infusoria can be restored to life after long apparent extinction, their ova may be supposed even more retentive of life; and he refers to an instance, reported by Ehrenberg, to the effect, that he had obtained certain microscopic living organisms from dry earth, had laid them away in his writing-desk, and at the end of four years had revived them by immersion in water. When an animal, as highly organized as a bed-bug, can pass a year without food, Ehrenberg's statement demands very little from our credulity. It is a notable fact, that the persistence of life in the bacteria or germs which cause those contagious processes known as fermentation and putrefaction, should depend in many on the absence (especially in those causing fermentation), in some on the presence, of air, thus giving rise to Pasteur's two classes, of aerobic and anerobic germs. Tyndall asserts that cold only benumbs bacteria, which even if frozen to 0° F., will revive at 40°; and Fisch's experiments proved that they could be subjected to still greater cold without losing reproductive power. While heat kills them, none the less, the spores of some fungi can resist boiling water, and, as is alleged, even caustic lime. Dallinger and Drysdale have demonstrated that, while living septic monads are killed by a heat of 140°, the spores of one variety—which are so minute, that they cannot be seen by the highest powers of the microscope, except in mass—are capable of germinating after being subject to a heat of 300° for ten minutes.† The "dry rot" fungi of decaying wood are well known; and recent experiments have proved that "the temperature at which dry rot proceeds most rapidly is 80° F., at 90° it is slower, 100° still slower, and at 110° to 120° is generally arrested. Its progress is rapid at 50°, slow at 36°, and is arrested at 32°; but will return if the temperature is again raised to 50°" (T. A. Britton). Dr. Alf. Carpenter reports (Br. Medl. Jour. Oct., 1879), that the germ of "potato blight" lies long dormant in the soil, ready to propagate; their spores resist heat, cold, sunshine, rain, and, for a short time, even boiling water; their development is arrested by sunlight and dry winds, and necessitates moisture, absence of sunlight, and excess of carbonic acid. The poison of "swine plague," or "hog-cholera," or "pneumo-enteritis" of the pig "loses nothing in potency by freezing, nor by preservation for one or two months closely packed in dry bran," as proved by direct experiments; while "there is good reason to believe that its power may be retained for a year or more. The poison in time loses its power, if kept in putrefying fluids or substances." (Rept. on Dis. of Swine, U. S. Dept. Agricult., 1879.)

Reverting now to the disease-poisons of man, and first to those proved to be due to living organisms, few facts of interest in the present connection are found recorded, except as to that disease which is unfortunately designated by many different names, among which are splenic fever, charbon, and anthrax. However, as to one other disease, Tinea tons urans, Aitken reports that it may be absent for years from workhouses and other such favorite habitats, and then reappear without apparently any fresh importation.

Respecting splenic fever or charbon, and its germ, the bacillus anthracis, the following facts are reported: Dr Alf. Carpenter states that this latent poison remained, in one instance, for three and a half years localized in one stable. Prof. John K. Mitchell reports that in hides this poison resists the process of tanning, prolonged boiling, and caustic lime. Bollinger (Ziemssen's Cyclop.) asserts that six months after the death of an animal by this disease its hide, soaked in a pond, infected twenty sheep washed in this pond, a saddler who worked on the hide, and two horses wearing the harness made of it; he farther teaches that while the freezing temperature renders this poison dormant and inert, as is the case in "other Saprogenic bacteria," yet, that even if the temperature be reduced to 0° F., the vitality of the poison is not destroyed, for it will revive if subjected to the requisite higher temperature. Ewart also asserts, as a result of his experiments, that the bacillus anthracis may be kept nearly at the freezing point without being destroyed. Davaine has successfully inoculated the dried poison, 22 months old, of this disease. Pasteur has successfully inoculated the disease after two years' cultivation of the original germs; and in 1879 he announced to the Academy of Medicine, Paris, "Charbon, septicaemia and chicken-cholera exist in the state of germs bottled in my laboratory. At will, during the last two years, for the two first, and for several months for the third, these germs, always ready, can be poured out for new inoculations and new deaths." He farther insisted that very different conditions are required for the cultivation of different germs; for

*The modes of distribution of disease-poisons are as interesting as, and more obscure than, those of plants. On this subject, and on the dormant vitality of seeds, Darwin contributes this interesting fact: "Professor Newton sent me the leg of a red legged partridge which had been wounded and could not fly, with a ball of earth adhering to it weighing six and a half ounces. The earth had been kept for three years, but when broken, watered, and placed under a bell glass, no less than eighty-two plants sprung from it."

†However, there is little reason to doubt that a heat of 300° F. is destructive to disease-poisons generally, and is therefore one of the most trustworthy disinfectants.

instance, that the "charbon-bacteria" would grow well in an infusion of beer-yeast, while the organisms of chicken-cholera would not grow in this, but best in chicken soup.

Dr. J. S. Billings reports that Koch "found that the bacteroidal forms of bacillus anthracis observed in the blood usually died in a few days, but that the spores retain their vitality for at least four years." Tyndall reports that "Cohn permitted the dried blood to assume the form of dust, wetted this dust, allowed it to dry again, permitted it to remain for an indefinite time in the midst of putrefying matter, and subjected it to various other tests. After keeping the spore-charged blood, which had been treated in this fashion for four years, he inoculated a number of mice with it and found its action as fatal as that of blood fresh from the veins of an animal suffering from splenic fever. There was no single escape from death after inoculation by this deadly contagium. Uncounted millions of these spores are developed in the body of every animal which has died of splenic fever, and every spore of these millions is competent to produce the disease."

James Law, professor of veterinary medicine in Cornell University, reported (p. 455, No. 4, v. 2, United States National Board of Health Bulletin, July 24, 1880) as follows: "Cooking is a very insufficient protection, as the resting spores have been shown to survive a boiling temperature, and, in particular cases, even 300° F., and a whole family were poisoned in Aberdeen, Scotland, by the beef that had been boiled for hours in broth. Further, and contrary to what holds with most other forms of virus, it is not essential that the skin should be broken in order to its absorption, and numerous instances can be adduced in which fatal results followed when it was deposited on the sound skin. Frost has no influence on its potency, and I have known a number of animals fatally infected by licking the frozen blood of a stoneboat when the temperature was below zero. Nor is time nor putrefaction to be relied on; I have known cattle to perish promptly after lapping the liquids that leaked from a grave in which an infected carcass had been buried nearly a year before. I have further known pastures on which the disease had been developed for the first time in the memory of the inhabitants maintain their infecting qualities for six years in succession and to yield hay which continued to infect animals when fed to them at a distance from such pastures.* Still more recently, Pasteur has reported as follows: "Recently we discovered them [the bacilla anthracis], in pits in which animals dead of splenic fever had been buried for *twelve years*, and their culture was as virulent as that from an animal recently dead."

In respect to this disease there are two other alleged facts of interest to the student who is seeking better to understand the nature of an unknown poison through knowledge of the conduct of known poisons. The British Medical Journal (June, 1879) reports that Davaine has found that, inoculating with the same septic fluid, the quantity necessary to kill a guinea pig was 100 to 200 times more in winter than in summer. Pasteur reports that birds are insusceptible to this poison, because their temperature is too high; and that he has proved this to be the case by immersing chickens (their normal temperature being 39° C.) in baths at 25° C. and at 30° C. and then inoculating them, with the result that in the former case the chickens die in 36 to 48 hours, but survive in the bath at 30° C.

Attention is now called to similar facts referring to those disease poisons which have not been proved to be living organisms; first, as to those poisons generally termed contagious; second, as to those which though not contagious are communicable and portable, and have been termed miasmatic contagious poisons; and, third, as to yellow fever.

Although the powers of resistance of the most familiar contagious poisons, as of small-pox, scarlatina, and measles, are generally admitted, very few definite authentic statements as to such powers have been found.

Dr. R. O. Doremus (referring probably to the poison of erysipelas and puerperal fever) reports that at one time the walls of the old New York hospital were scraped in vain to rid it of infectious disease-poison, for the very stones were impregnated; and that in the numerous cases where the wooden, plaster, brick, or stone walls of inhabited structures do become saturated, as it were, with the poison, there are only two remedies—either the heroic employment of the most potent chemical disinfectants, or to "break down the house, the stones of it, and the timbers thereof, and carry them forth out of the city into an unclean place." The power of vaccine virus to be transmitted, without apparent loss, through hundreds of persons is well known; it is also taught that while this power is lost after exposure of this poison to a heat of about 140° F., yet that it is not injured by intense cold; and vaccine lymph has maintained its full power for seven and even nine years after preservation by the method of Dr. Husband, of Edinburgh (pp. 17, 18, 25 of John Simons' "Second Report, Public Health," London, 1860). Grisolle teaches, as to the poison of small-pox, that "this virus can, in certain

* Professor Law also asserts (p. 454) "that the cooking of tuberculous matter gives no guarantee of protection, as flesh is a poor conductor of heat, and tubercle that had been boiled from a quarter to half an hour had readily infected a number of animals that partook of it."

conditions, preserve its power during several years—some say ten, twenty, even thirty years. In fact, cases are reported of grave-diggers being infected in exhuming, after such long intervals, the bodies of those who died with small-pox. However, such statements should be accepted with the greatest reserve." The tenacity of the poison of scarlet fever is well known; it "clings long to rooms and houses, even for many months." Ziemssen's Cyclopædia reports instances of dormant vitality for two, five, fourteen, and eighteen months; and the destruction of the poison by a dry heat of 212° F.*

While many more persons are susceptible to the poison of measles than of scarlet fever, yet it is admitted by all that the vitality and tenacity of the former is much less than of the latter. Dr. Home, of Edinburgh, experimenting in 1758, found that "rags soaked in blood retained their infective properties only ten days." How long this poison may remain active in clothing and such objects is unknown.

The poisons of cholera and of typhoid fever are the most important, and to yellow fever the most closely allied, of those disease-poisons which are non-inoculable, yet transmissible, and are now classified as miasmatic-contagious poisons; being characterized, apparently, by the peculiarity that, while they come from a sick person, they yet require, outside of the body, favorable conditions for further change or development before acquiring any infective poisonous power.† The resistance of these poisons will now be considered.

Dr. B. W. Richardson, the distinguished physiologist and experimenter, teaches, "almost all the organic poisons [among which yellow fever is especially named] are preservable by cold. We can keep them any length of time; in fact, I should think there is no limit to the preservation of them by extreme cold. We have seen this illustrated on a large scale in northern capitals, where these poisons have been locked up for months by the cold. The poison of cholera in St. Petersburgh has been locked up in the snow for a whole winter, and on the solution of the snow the poison has become active by being carried in the surrounding streams and taken into the drinking water." Dr. Vanderpoel refers to the poison of cholera having remained dormant, on one occasion in Russia, for two years; and Dr. Macnamara asserts that if fresh cholera dejections be dried and protected from moisture they retain their poisonous activity for years. It is a fact familiar to all who have any experience or knowledge of cholera, that once introduced into a place it is prone to linger several successive years, as in Cuba, 4 years, 1833-1836, 6 years, 1850-1855, and 4 years, 1867-1870, repeatedly declining, even disappearing for months, then reappearing with renewed violence. Such occurrences must be due either to repeated fresh importations or to the vitality of the poison persisting through repeated stages of dormant vitality; attending circumstances favor the latter more than the former view.

Similar facts are recorded as to the poison of typhoid fever. Dr. Rochester is not alone in reporting [pp. 134, Trans. Amr. Medl. Assn., 1879] that he has observed several instances of this disease which could be traced to no other source than ice, and therefore that this poison "is not destroyed or impaired by freezing."

Dr. Cayley, in his recent admirable "Croonian lectures" on this disease (British Medical Journal, March, 1880), states that its poison in a large running body of water, freely exposed to the air, is apparently soon rendered inert, while in close confined situations it retains its activity for an indefinite time. He also reports two remarkable instances of the potency of the poison after wonderful dilution, for instance: an epidemic in 1872, at Furlenthal, in the Jura Mountains, was manifestly due to some of

* The notable resemblances, in certain particulars, in the conduct of the poison of scarlatina, a disease with which physicians in tropical America have little experience, and of yellow fever deserve to be remembered. "Sometimes epidemics of scarlet fever are not coincident in neighboring localities connected by constant intercourse, a proof that in this question local conditions play an important part, and are frequently of determining influence." "It has often been noticed that while scarlatina attacks one village with severity, a neighboring locality, in spite of the active intercourse between them, remains entirely free, or suffers very mildly from it; this fact has frequently been used as an argument against the indisputable contagiousness of scarlatina. We meet with it in the etiology of typhoid fever and cholera, and explain it by conditions of the subsoil, essentially independent of any human agency. The same explanation might serve in the case of scarlatina."

Sporadic cases of scarlatina often occur, "appearing to have had no local or temporary connection whatsoever with others, which fact has given rise to the opinion that scarlatina could originate spontaneously through the agency of certain unknown atmospheric and telluric influences." "Observations on the origin and spread of epidemics of scarlatina continue to prove the paramount importance of personal intercourse. Though we cannot understand why this intercourse in a few, or even in many cases, has not been followed by a marked spread of the poison, we, at the same time, cannot shut our eyes to the fact that in the majority of cases it is the only causal factor which we are able to demonstrate." "Scarlatina, to a greater degree than perhaps any other disease, appears at one time in the form of a severe, at another in the form of a mild epidemic, and the same variation is noticed in the sporadic cases." (Extracts from the article on scarlatina in Ziemssen's Cyclop.)

† However probable it has not yet been proved that the poison of yellow fever is reproduced in the human body and comes from the sick; some able thinkers believe that it is reproduced exclusively outside of the body, that a sick man is no more dangerous than a healthy one coming from an infected place, and that both are dangerous for the same cause as, in the same way as, and to less extent than bundles of old clothes, bedding, baggage, &c. If the former view be correct, yellow fever would resemble cholera and typhoid fever, but if the latter be true, then yellow fever would be the only known specific spreading disease thus characterized.

the water of a large stream, which had received typhoid stools, percolating many thousands of feet under a mountain to the fountains of the adjacent village of Furlenthal; and an epidemic in 1879 at Caterham, England, was traced conclusively to a few splashings from a bucket containing typhoid stools into the immense reservoir of the water-works. Dr. Cayley further cites instances wherein the poison remained dormant nine months and even two years. Liebermeister states that this poison has been proved to lie dormant at least nine months, and that, since in one instance six cases occurred, at intervals in one house during eight years, it is probable that the poison can lie dormant from at least one to two years.

Many similar facts are recorded as to yellow fever, some of which will now be presented. Outbreaks of yellow fever on vessels, weeks and months after having touched at some habitat of the disease, or after having been otherwise subjected to infection, have occurred so frequently as to give rise to the belief in the spontaneous origin of yellow fever in ships. Unfortunately, for present purposes, these cases, for the most part, are not reported with sufficient precision respecting either dates or other essential details. However, numerous cases are on record proving that the poison may remain dormant from two to three months. Repeatedly has "a ship epidemic, interrupted by a voyage into cold latitudes, as Newfoundland and Cape Horn, reappeared two or three months after its interruption." The most recent alleged instance of this kind (except the instance of 58 days' dormancy, cited in chapter VII) occurred on the United States steamer Plymouth, reported by its surgeon to have been "altogether a particularly clean ship," but the inner planking and the beams and knees were, in many places, badly decayed. The Plymouth coaled at St. Thomas (where there was yellow fever, October 21 to 25, 1878; then visited on the 25th the adjacent island of Santa Cruz, where it was known that one death by yellow fever had occurred in October. From November 4 to November 7 (when the Plymouth sailed from Santa Cruz for Norfolk), seven persons on board were attacked with yellow fever, and there were no other cases. The Plymouth returned to the United States, and remained from November 30, 1878, to March 15, 1879, at the extreme northern harbors, first of Portsmouth, then of Boston. The Boston Medical Journal of July 24, 1879, reported, "While in dock [at Boston] the Plymouth was fumigated three times, one hundred pounds of sulphur being used. Most, but not all, the stores were removed from the ship. The cold was such that ice formed and remained several days in most parts of the ship, but much of the time there was a fire in a coal-stove in the fireroom for the use of the workmen." On March 15 the Plymouth sailed for the West Indies; on the 19th, in consequence of a storm, "the hatches had to be battened down, and the damp berth-deck became very warm; a tropical condition prevailed." On March 21, one of the crew, on the 23d another, sickened with yellow fever (these being the only cases), and the steamer, when at 27° 40′ N. latitude, headed north. This instance tends to prove a dormant vitality of the poison of yellow fever during the four and a half months, November 7, 1878, to March 21, 1879. It also tends to prove great power of resistance to cold, perhaps also to sulphur-fumes, at least under certain circumstances; and directs suspicion, by no means for the first time, to the "badly decayed" wood-work of the steamer, as the specially favoring circumstance.* In connection with this, it is worth noting that Dr. Heinemann, of Vera Cruz, has recently called attention to the repeated introduction of yellow fever into vessels at Laguna, a maritime timber-mart in Mexico, apparently by no other means than by the timber floated to the vessel and taken on board by those who sickened without having visited the shore or having come in contact, as was confidently believed, with any other infected things or persons. As is well known, wood is the favorite habitat of many fungi.

During the same years, 1878, 1879, there occurred on land a similar instance, as is believed, of dormant vitality. Memphis, having, in 1880, 33,593 population, a large portion of whom fled, had about 17,600 cases of yellow fever in 1878; the last death was reported on November 12. The winter was severe; one unusually heavy snow storm, as early as Christmas, fell to the depth of several inches. In 1879 Memphis suffered again severely, the first recognized case occurring July 6, at a time when no cases could be found nearer than Havana, and no proof could be obtained of a fresh importation. Hence, there was in this case evidence, and very good evidence, of a dormant vitality for nearly seven months, December 12, 1878, to July 6, 1879. Added to

*The "Report on Yellow Fever in the U. S. S. Plymouth, 1878–'79, Bureau of Medicine and Surgery, United States Navy Department, 1880," details, on p. 16, the disinfecting measures resorted to, and also states the following facts of interest: The sanitary board, charged by the Inspector-General, U. S. Navy, with a special investigation of the Plymouth, after the second outbreak of yellow fever, reported that there were throughout the ship many spaces converted into reservoirs for confined air, much decomposing and offensive refuse, very extensive decay of the woodwork disclosed in concealed places, much "nearly solid matter consisting largely of bacteria," and living active flies crawling out from confined spaces; thereby proving that these spaces had not been sufficiently chilled to kill the flies, although ice had been long standing in the fire-room. The presence of the bacteria and of the flies conclusively proved the presence of conditions favorable to the growth of living organisms, and that these had not been destroyed either by the cold or by the disinfectants which had been apparently well employed.

many other grossly insanitary conditions, Memphis had many streets paved or planked with badly decayed wood.

The reported cases of the occurrence of yellow fever in persons engaged in unpacking trunks containing the apparel of those who died with yellow fever are very numerous, and deserved much more careful record than their reporters have, for the most part, given them. If more carefully detailed and better authenticated, these recorded cases would have long since settled several disputed points of importance. It is worth premising, in respect to formites in trunks, that "fungi, when lodged in trunks among filth and animal matter, find in darkness and dampness the fittest imaginable growing place"; a fact equally true of the holds of ships, and of the circumstances usually attending dirty clothes and bedding. Neglecting numerous instances which tend to prove shorter periods of dormant vitality, two, which refer to the longest period known to me, will be cited. Dr. C. M. Smith, of Franklin, now president of the Louisiana State Medical Society, reports one instance where the opening of a trunk, two years after the packing of the effects of a person dying with yellow fever, was followed by cases of yellow fever, under circumstances which rendered it as certain as failure of counter-proof can render anything, that the cause of the fever came out of the trunk. Dr. Hulse, of Pensacola, Fla., reported the following instance: "In 1853, a Mr. Lane was attacked with yellow fever at Dr. Fisher's, in Milton [which is a few miles from Pensacola]. His effects were packed in a trunk, which was locked, placed in a store-house, and covered with old cloth and sacks. In the summer of 1855, two years later, this trunk was sent from Milton to Brooklin in Alabama, 40 or 45 miles north, and it was opened in a house in presence of several persons. Soon after, six of those living in this house sickened, and several died with black vomit." Though such instances as these two fall short of absolute scientific proof, they none the less justify, in connection with proved facts respecting like disease-poisons, a very strong suspicion that the poison of yellow fever may, under favorable circumstances, preserve its virulent power during at least two years of dormant vitality.

The following instance is interesting for its apparent illustration of unfavorable influences, other than time, which the poison can resist. Dr. Rochester reports (pp. 128-9, Trans. Amr. Md. Assn., 1879) that "In September, 1856, an infected ship from Cuba was detained at the quarantine anchorage off Staten Island, N. Y.; several passengers had died and some were ill on board. The garments and bedding were thrown overboard. Bay Ridge, a delightful suburban neighborhood of Brooklyn, the seat of choice country residences, lies directly across the bay, distant about one mile from the anchorage mentioned. The wind and tide deposited a number of the garments that had been thrown away on the beach which terminated the lawn of Col. Chas. Prince, an old and respected resident. In taking his usual morning walk, he discovered the clothing, and examined it with his cane, not otherwise handling it. He had no suspicion that it came from quarantine, and never saw it again. In four days he was taken ill, and died in a week from yellow fever * * *. The son and daughter, adults, and the colonel's only children, were also attacked; the son died, and this was the commencement of an epidemic which destroyed many lives in a limited area, but which was stopped by enforced isolation, and by destruction of bedding and garments. The clothing which produced all this evil had been saturated with salt water for hours before it made its fatal landing."

All the facts and considerations thus far presented tend to disprove the doctrine of the spontaneous origin of the poison of yellow fever, as well as of all other specific spreading disease-poisons; and to encourage those, who concur with Aitken in condemning this doctrine as irrational, in crediting the apparently least credible instances of dormant vitality, a power proved to be possessed by disease poisons, rather than in crediting the apparently most credible instances of *de novo* origin, a wondrous power unproved to be possessed by the poison of any specific spreading disease. Before yielding faith to such an origin, science demands the most rigid and conclusive proofs, such as have never yet been presented.*

There are other important properties of the poison of yellow fever which deserve consideration. Some of these will be briefly noticed. The portability of the disease, now taught by every recent medical text-book, is deemed too firmly established to require lengthy discussion. Such facts as the introduction and spread of yellow fever, for the first time, in the island of Ascension, in 1823; in the island of Boa Vista, in 1845; in St. Nizaire, France, in 1861; in Swansea, Wales, in 1865; in Madrid, Spain, in 1878,† together with the marked modern tendency of the disease to cling close to

* It is freely admitted that some of the instances of persistent vitality, etc., of disease poisons, previously cited, tax one's faith severely, and that probably those who reported them overlooked some more likely causal condition. However, I can credit even the most remarkable rather than spontaneous generation.

† Since little is generally known of this last important incident, the following details deserve record: Dr. Guichet, surgeon in the French army, charged by the government with a special scientific mission in Spain, officially reported in 1879 the following facts: Madrid is 2,214 feet above the sea. In 1878 a number of soldiers returned from Cuba, having been discharged because the insurrection had terminated. All of those at Madrid were apparently acclimated, certainly none came with yellow fever, nor

railroads, and to rivers navigable by steam, and the successful tracing out of the disease in armies and navies, are broad general facts supported by so many minor proofs of the most positive character that even the majority of those who credit the spontaneous origin of the disease have been forced to admit that it is portable, that is, in some wise communicable, or, in other words, indirectly contagious. For, by some of the best modern writers, contagion is now used in an extremely wide sense, so as to include contact with any transmissible poison, whenever and however brought about, and not simply immediate contact with a poisoned person. Hence, much of present disagreement about the contagiousness of yellow fever is due to use of the same word in different senses.

Experience seems also to have induced general concurrence in the view that the disease can be imported by a healthy, as also by a sick person, from an infected place,* and that, on the whole, things or fomites are more dangerous than persons; some even contending that fomites alone are dangerous, persons not at all so. On this subject, Heinemann reports two facts of interest from Mexico. From an infected place, a lot of assorted goods were sent to a merchant in a distant inland town, first by healthy men in skiffs or boats to a healthy place, secondly by muleteers, who were never near either sick persons or infected places; and yet these muleteers, while transporting these goods, were nearly all struck down by yellow fever. In time of war a band of native soldiers, almost unclad and with little or no baggage, came from a badly infected to an uninfected town, without importing the disease; soon after a band of European soldiers, well uniformed and having much baggage, came from the same infected to the same uninfected place, and yellow fever followed the visit of the latter.

Another curious property of the poison of yellow fever has been repeatedly noted. Very often the first set of cases has occurred one, two, or three weeks, sometimes longer, prior to the second set of cases, which begin, as it were, the resulting epidemic. If the poison be supposed to be an imported living organism, then the conclusion would be, as Prof. J. K. Mitchell long since indicated, that the first cases resulted directly from the imported poison, and that considerable time was often necessary for the growth of a second crop. The view that the poison is due to some extra microscopic living organism peculiar to the tropics would also explain why the poison produces such poor crops in temperate regions, and why its reproduction is arrested by cold. This view best explains also the frequently observed and unquestioned fact, that those who live and sleep nearest the ground suffer most with yellow fever.

Another property deserving attention is the portability of the poison by the wind. Under ordinary circumstances, the distance must be very little indeed; a fact which does not prove that it may not be considerable under unusually favorable circumstances. Vera Cruz, Havana, New Orleans, all have places within ten miles or less which have repeatedly escaped, when those cities suffered severely with the disease. The Fort Barrancas barrack, Fla., is located 50 feet above the plain, is three stories high, and is within three quarters of a mile of the Pensacola navy-yard; yet, in 1867, the soldiers secluded in this barrack, occupying as they did the third story, enjoyed complete immunity, while the disease prevailed severely at the navy yard (pp. 149, Circ. No. 1, U. S. Surg. Genl. 1867). Surgeon Lawson, Inspector-General of Hospitals, reported in the British Medical Journal, May 1879, that at Newcastle, Jamaica, in 1856, of "seven cantonments on the narrow crest of a mountain spur, there were three sickly zones, alternating with four healthy ones, in a length of 800 yards," which would give a distance of only 343 feet between the cantonments. The fort San Juan de Ulua is opposite to Vera Cruz, the distance being less than three quarters of a mile, and the anchorage ground lies between them, yet others beside Dr. Heinemann and the United States consul, Dr. Trowbridge, assert that, even when yellow fever is prevailing in both places, and boats (often having sick and fomites on board) closely approach vessels in the frequent passage of these boats between the fort and city, these vessels are never thus infected. The vessels anchored in the harbor of every infected place constantly give proof that habitually the wind plays a very subordinate

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had it while there. But a number of young people who lived side by side these soldiers, and their clothing, trunks, and baggage, were attacked. The epidemic was restricted to a very few squares adjacent to the crowded domicile of these soldiers; beginning September 15, it was ended by October 15; there were "twenty-five cases perfectly well known, but according to the most authoritative medical statements, there were more than 50 sick, with about 35 deaths." Spanish physicians, though many in Madrid have served in Cuba, seem not to have doubted any more than did Dr. Guichet that the disease was yellow fever; and the diagnostic and post-mortem details confirm this view. The proofs seem good, and the opinion unanimous, that the yellow fever at Madrid in 1878 was due to the importation of disease-germs in the infected clothing and baggage of healthy men recently returned from Cuba."

* Sanitary inspectors, seeking to trace out the mode of origin of cases of yellow fever, should not neglect, when the mode of origin is doubtful and obscure, to investigate whether this cannot be traced through some of the concealed by-ways of illicit sexual intercourse. Surgeon Donnet, R. N., in his admirable official report of yellow fever at Jamaica, 1867, attributed the disease in the Aboukir to the intercourse of the crew with prostitutes who neither had the disease nor came from an infected place, but had recently herded on shore with healthy seamen from infected ships. Three other instances could be cited, in which the mode of origin could not be traced, except through concealed facts relating to sexual intercourse.

part in disseminating the poison; even at Havana, vessels anchored in the open harbor are rarely infected, yet it is impossible to anchor there farther than 1,500 feet from the shore, and it probably is never practicable to secure this distance from both the shore and an infected vessel. The maritime sanitary authorities at Martinique indicate that from 40 to 65 feet to the windward of an infected vessel is a safe distance for an uninfected vessel to anchor at; and Mélier's experience at St. Nizaire was to the same effect. Much more evidence could be presented in proof of the short distance ordinarily requisite for safety, and still leave for answer the important question, to what greatest distance may the wind, under the most favorable circumstances, transport the poison? Rejecting, as unworthy of any faith, unfounded statements and vague suspicions to the effect that the poison may be conveyed 30 or even 50 miles, I have found the following apparently credible reports on the subject. Some have estimated the greatest distance to be 500 yards; a New York commission concluded that it was 300 yards; Dr. Vanderpoel states, but omits to give the proof, that poison has been distinctly traced over 1,000 feet; while Mélier, who reports the most carefully observed instance on record—an instance in which it was proved, as fully as negative evidence is ever likely to prove such a question, as that the poison could not have been conveyed by other means—states that this greatest distance was 260 metres, or 853 feet. In any case, everything known on this subject tends to give assurance that winds are little to be dreaded as transporters of the poison, since their power is ordinarily restricted to very short distances, and at the most does not exceed a few hundred feet. Still further, the marked localization of the disease, which so frequently characterizes yellow fever, renders it impossible to believe that prevailing winds can have a predominating influence in spreading the poison.

It is evident that these considerations leave little reason for faith in "the epidemic-wave theory" of yellow fever; which faith would have us believe, for instance, that this poison could begin its aerial pilgrimage at Rio Janeiro in the winter of 1849-1850, and, extending gradually along the South American coast, through the Antilles, and across to the United States, reach Norfolk, Va., in 1855. Those thus believing must be hopelessly incredulous as to the influence of commercial intercourse.

CHAPTER IX.

THE ALLEGED SPONTANEOUS ORIGIN OF YELLOW FEVER ON SHIPS.

The power of specific spreading disease-poisons to resist the destructive influence of time and other deteriorating agents, and to lie dormant without giving any evidence of their presence until conditions arise favorable to their action and growth, is well established, while the power of these poisons to develop spontaneously remains unproved.* Advancing knowledge has constantly tended to strengthen confidence in the one power, which has been conclusively proved, and to destroy faith in the other, which finds at the present day less reason for acceptance than ever before.

None the less there remain many who consider yellow fever a disease so exceptional to all other migratory epidemic diseases, that they believe it to have thousands of spontaneous birthplaces, scattered around in one restricted section of the tropical circle of the earth, and especially in those parts of this limited region where a few white men may happen to gather together. It is more surprising that a few physicians are yet left who vehemently teach that yellow fever is a still more astoundingly exceptional disease, in that it originates *de novo* in ships, even in no other places; and, in that this procreative power is enjoyed by only those ships which sail in the special sections of the earth-encircling ocean which are, for convenience, designated the tropical Atlantic, the Gulf of Mexico, &c.; in other words, only in those very limited sections of the single homogeneous cosmical ocean which washes the very shores where yellow fever habitually prevails. Thus, it is claimed, as a *sine qua non* for the generation by ships of this so-called "nautical," "oceanic," "pelagic" disease, that these ships must be sailing in about one-fourth part of the oceanic tropical region, for, the other three-fourths are mysteriously deprived of this terrific pestilential power. Vessels charged with every variety of cargo, passengers, and crew, with every possible diversity and quantity of filth, and, under these conditions, subjected, for months, even years, to an ardent tropical sun, sail from the east coast of Africa around three-fourths of the globe to the western coast of America, with admitted impunity; but, it is claimed, that if the same vessels, under the same conditions, venture to sail within the remaining limited section of the tropical ocean, great risk is incurred in having yellow fever, destitute of any ancestry, spawned on board. Surely, nothing less than the most absolutely rigid scientific proof can justify belief in a doctrine so marvelous and

*Recent researches seem to prove that disease-germs may even grow innocuously, and the growth become virulent under conditions favorable thereto, such as are perhaps found in the holds of vessel.

incredible. On what evidence does such proof depend? Since the proposition is an affirmative one, one single conclusively proved instance of the spontaneous origin of yellow fever on a ship, would logically force the admission that the disease *can* thus originate, and would render the citation of numerous instances, even of two, superfluous for any purpose except to demonstrate the frequency of the occurrence. There are numerous reports of single instances of the alleged origin of yellow fever on ships, but to La Roche, the best and the most industrious compiler of yellow-fever literature, is due the largest and most instructive collection of such instances. Subsequent writers have done little more than copy from this compilation extracts, which they claim are "conclusive"; therefore, a brief but adequate notice of this alleged conclusive evidence will suffice.

La Roche devotes 36 octavo pages (pp. 421–456, v. 2) to this evidence, and cites references to at least eighty instances, which, for the most part, occurred many years ago, when medical reports were characterized by even less regard than now to logical essentials. From all the instances referred to, La Roche concluded to select only fifteen of those most conclusive, subsequently admitting, however, that even some of these are not thoroughly conclusive. In only two of the fifteen instances is the vessel alleged to have originated the disease, without having recently touched at some habitually infected place or having been infected on some prior occasion. This of itself suffices to arouse incredulity, for is it not extraordinary that, among the thousands of vessels which for so many years have annually traversed the American tropics, La Roche, with his enviable industry, should have failed to collect more than about eighty instances, and of these only two which were not known to have recently communicated with an habitually infected region of country?

The most decisive one of these two instances occurred as long ago as 1799, in the United States frigate General Greene, while sailing, in June, from Newport, R. I., to Havana. Dr. Kallock, the reporter and apparently the surgeon on board, designated this outbreak "a malignant disease," and a Dr. Halliday, of Havana, "identified it as yellow fever"; but no good reason is given to induce the belief that the physicians possessed in 1799, that which very surely their successors at the present day do not possess, infallibility in the diagnosis of yellow fever. This frigate is said to have been a new one, but not one word is said as to how many years it had been in service, what ports it had previously visited, what vessels it had been in contact with, what stores, baggage, or persons from infected places may have been on board, or any other word bearing on previous opportunities which the invisible poison of yellow fever may have had to steal on board and lurk in a dormant state until awakened by tropical heat and other requisite conditions. All reference to such opportunities for infection is conveniently omitted; and yet, Toner's Table of Yellow Fever Localities in the United States records that, in 1798, not less than eleven places in the United States, from Boston to Charleston, including places of such importance to a United States man-of-war at Newport as Boston, New York, Philadelphia, Baltimore, Norfolk, and three places in Connecticut, were infected by yellow fever; and that in the very year 1799 not less than seven places, from New York to Charleston, were also infected. Is not this ample proof that there were abundant opportunities for the introduction of infected stores, baggage, &c., on board the General Greene? The facts in the case suffice to prove that uncertainty as to the diagnosis, and, above all, the negligence and inadequacy in reporting details essential to the case, render this instance utterly worthless as evidence; it is no more than the direct testimony of one favorable witness never subjected to cross-interrogatories, and while it would be hooted, as proof, out of any decent court, it merits even less respect in the high court of science. Respecting all such reported instances, it should be remembered that sanitary officers of experience and repute are now often demonstrating, in frequent published reports, the possibility of tracking out communicable diseases in cases where the practitioner, inexperienced in such matters, has declared that no traces existed. It is self-evident that a thoroughly exhaustive investigation cannot be expected from an ordinary and indifferent physician, nor from a medical officer whose ignorance and negligence were very probably responsible for the presence of the very disease he is charged to investigate; nor, least of all, from those whose theories convince them that no investigation is necessary, since spontaneous origin readily explains everything, and conveniently dispenses with a labor which not infrequently taxes to the utmost all the knowledge of an able physician united with the patience, perseverance, and tact of a skillful police detective.

The second instance cited of alleged spontaneous origin occurring on a vessel not reported to have recently touched at an habitually infected port, is subject to all of the preceding criticisms. Respecting all essential particulars which concern previous opportunities to become infected, not one word is said except as follows: "In 1799 the sloop Mary was sent into Philadelphia as a prize to the ship of war Ganges. She was not from a sickly port, and at the period of her arrival there was no one sick on board." It seems incredible, but it is true, that it is not deemed necessary, respecting this "con-

clusive" instance, to say one word as to the history and condition of the Ganges any more than of the previous history of the Mary.

In all of La Roche's remaining thirteen instances alleged, to be "conclusive," the vessels had touched at habitually infected shores, which, however, are reported with a reckless audacity, offspring of credulity, to have been free from yellow fever at the time when visited by the vessels found subsequently infected. Three instances, among the thirteen, of this credulous audacity will suffice. Yellow fever is alleged to have originated spontaneously on the United States ship Hornet in September, 1828, when anchored three miles from Vera Cruz, where, as is reported, yellow fever did not prevail. Yet, whoever will examine Bouffler's statistics (pp.11–14) of the civil hospital of Vera Cruz, will find that during 1822–1836 there were more cases in this hospital in 1828 than in any other except two of these fifteen years, and that there were cases and deaths by yellow fever in every month of the year 1828! Two other vessels, which are alleged to have originated yellow fever on board, both in 1822, and after visiting Havana, were the United States man-of-war Macedonia, which is cited as particularly "*deserving our serious consideration*," and the United States brig Enterprise. To the details in these instances it is gravely appended, "There was, as we have seen, no yellow fever at the time in the city or port of Havana, and the same fact has come to my knowledge through other channels." Cuban authorities testify most positively that yellow fever has annually prevailed in Havana since 1761; the evidence of its monthly prevalence throughout every succeeding year increases from 1805 to the present day; and, during this very year 1822, Dr. J. F. De Madrid, of Havana, delivered a public address in this city respecting the constant prevalence of "endemic yellow fever," while Codinach and Maher testify to the same effect. (See Chapter XVII.) In spite of this we are required to credit "my knowledge through other channels," that after "the 20th of June" and "in the summer of 1822" there was no yellow fever in Havana! Is it not courtesy to designate such statements reckless audacity?

Neither the remaining ten instances of La Roche, nor those of others, present any stronger evidence than do the five instances above cited, in proof of a doctrine which, without the most conclusive proof, is, with our present knowledge of disease poisons, totally incredible. Manifestly, easy credence has been given to those who deserve very little, namely, to residents of an habitually infected place, when reporting that said place is, at some specified time, no longer infected. Few residents are well informed respecting the presence of diseases, and often falsify unintentionally; self-interest prompts all commercial communities to suppress information concerning communicable diseases; and, if these habitually prevail, an indifference to them grows up, which induces those exposed to ignore them, and no longer to appreciate their importance. For such reasons the whole truth is rarely discoverable, except by the thorough investigation of a competent and authorized sanitary officer. In Cuba numerous respectable witnesses can readily be found who will testify that yellow fever does not exist in localities where proper inspection will readily disclose it. These witnesses may be found among the best citizens, among physicians, among consuls, and among even commanding generals of the very locality.

The ill-founded belief in the origin of yellow fever in ships is sustained by two great errors—disbelief in the dormant vitality of the poison, and easy credence in evidence tending to prove no opportunities of introducing the poison. The last error has in numerous instances been due to misinformation received at a port respecting the presence there of the poison, and it is therefore deemed important to teach some practical lessons respecting this misinformation. From many examples, four within my own experience, and respecting the principal ports of Cuba, will be selected; and it is important to remember that I, while in Cuba, was supported by the whole authority of the Government of the United States, and also that of Cuba, and was therefore less exposed than even medical officers, much less ordinary civilians, to sources of error.

In one instance a consular officer reported officially in writing that there was *no yellow fever* at his port. I did not believe it, and therefore requested him to specify whether there were or were not *any cases;* if so, how many, &c. His reply was, that there were *the usual number* of cases of "the yellow-fever endemic," but that he had supposed the inquiry referred solely to "epidemic yellow fever," which, he repeated, did not exist. Farther investigation developed the fact that, in this large town, there were less than 100 susceptible persons out of which to manufacture an epidemic. A United States consul at another port officially reported the entire absence of yellow fever, and other "reliable" persons confirmed this evidence. Fortunately, the first physician at this port happened to be a friend, and on visiting him he detailed four cases within his own knowledge, together with the information that the town had suffered so severely a few years previously, that very few susceptible inhabitants were left. In a third instance, the commanding general at a very important port personally assured me one morning that yellow fever did not prevail, and that in all there had been only two or three cases; he, at the same time, furnished every facility to test his correctness, and, before the day had closed, one of his own army surgeons had given me a written list of a number of cases, and I had inspected

in the hospital five certificates of death, and there saw more cases then present than the general had reported to have occurred during the whole season. He was as evidently misinformed as he was not untruthful, but he justified me in reporting to some such effect as that "yellow fever does not prevail this year at ———, as I am assured by the very highest authority"; if such a report had been written, and assuredly it was not, a gross falsehood would have been taught. In a fourth instance, two resident physicians assured me that there was no yellow fever at their town, but, subsequently, two of their colleagues detailed several cases which had occurred in their practice. Now, let it be observed, that in not one of these four instances was there the least reason to suspect intentional falsehood.

Experience, in places habitually infected by yellow fever, abundantly teaches that easy credence is not to be given evidence to the effect that the disease has ceased to prevail, or has failed to reappear at the usual season, unless this evidence is derived from the highest sanitary officer in the place, and that even he should not be fully trusted unless it be known that he is not only competent and trustworthy, but also that he is officially given ample opportunities to know whereof he testifies. Further, even in the event that there is not, at a given time, one single case of yellow fever in an habitually infected place, this is not proof that the poison may not be abundantly present, and prepared, if subjected to favorable conditions, to demonstrate its presence with conclusive fatality on those susceptible to it. At the close of every epidemic some of the unacclimated, who have been constantly exposed, continue to escape, while others, recently arrived, succumb; in this fact of common experience is a proof, additional to others unnecessary here to repeat, that the poison may be present yet fail to disclose any evidence thereof.

Finally, respecting the evidence in favor of the origin of yellow fever in ships, the eminent teacher, Professor Haenisch, declares (p. 491, v. 1, Tiemssen) that "yellow fever has never yet been observed on a ship which has not, in some way, come into communication with the land or with some other ship where the disease already prevailed"; and that distinguished scholar, Prof. Auguste Hirsch, than whom there is probably no man more familiar with the literature of yellow fever, wisely and emphatically writes as follows: "Observations teach that ships free from yellow fever acquire the disease only by direct or indirect communication with infected ships or places. There does not occur in the entire literature of yellow fever one single trustworthy fact respecting the occurrence of the disease on any ship sailing or anchored within the yellow-fever zone, except under the above-named conditions." "Reports recounting the occurrence of the disease on ships without direct or indirect communication with infected ships or harbors, are not deserving of the slightest confidence."

Having shown how inconclusive is the evidence in favor of the ship origin of yellow fever, it is necessary now to record the evidence against such an origin. The first fact of importance is that it would be difficult, if not impossible, to cite an instance among the world-renowned contemporary authorities in medicine who support the doctrine of the spontaneous origin of yellow fever anywhere, much less on ships. While most of these have no personal experience with the disease, it is as strikingly true that they are thoroughly familiar with the published evidence, and that they are most competent to form and most disinterested in forming correct conclusions therefrom. The unanimity of their conclusion against the local origin of yellow fever demonstrates the weakness either of the evidence favorable thereto or of those who present it. But, apart from this and other general considerations which have been presented, the special evidence of those having greatest personal experience with vessels frequenting infected ports is extremely instructive and decisive. It is necessary to introduce this special evidence with several general observations.

In the first place, none of the pertinent evidence, pro or con, has been, nor will it be, suppressed, since the triumph of truth, and not of any man's doctrine is alone sought for. In the next place, the doctrine now treated of is, as will be seen, a very old one, and the evidence to be presented is derived from witnesses who, because of their familiarity with this doctrine, have examined the facts bearing upon it with critical acuteness; and this has been done in comparatively recent times, so that the facts on which the conclusion is based could in some measure be tested, as cannot be the case with antiquated reports, especially with those by reporters who manifestly failed to appreciate the premises necessary to their conclusion, as is well illustrated by the inconsequent and illogical report of the above-cited case of the frigate General Greene. In the last place, it is requisite that the medical as well as the unprofessional reader should be impressed with the following obvious facts: Men who have studied a disease in one place only have not enjoyed as good opportunities as those who have studied it in many places; practitioners of medicine obtaining their livelihood by their skill exclusively in the cure of disease, are by no means necessarily well informed respecting its causation and prevention, and therefore far less deference is due to their authority than is due to that of those physicians who have made these their special study; and those medical men who have had most experience with infected vessels are assuredly the best witnesses respecting this subject. For these reasons, consuls, sanitary officers,

and naval surgeons, on duty at infected ports, and especially those among them who have been officially charged with the responsibility of marine sanitation in ports infected by yellow fever, are, of all other witnesses, those best entitled to confidence. Of all such witnesses, none deserve more respect than the French, for the reasons that the colonies of France in tropical America and Africa have long presented unsurpassed opportunities, and no nation has had for so long a time a sanitary organization served by medical officers competent to utilize their opportunities, and stationed where these were abundant. Their evidence is emphatic and unanimous.

The first witness to be presented is the only antiquated one, and he is summoned chiefly to prove the antiquity of the theory of the ship origin of yellow fever;* almost all other witnesses are living men of distinction at the present day.

Kéraudren, "chief physician of the French navy and inspector-general of the marine sanitary service," wrote in 1823 (pp. 29, 36) as follows: "It is constantly observed that vessels anchored at some distance from the shore and whose crews avoid communicating with the land, have escaped yellow fever solely by this precaution." "There are those who pretend that yellow fever can develop spontaneously on a ship at sea. By spontaneous development they mean, without doubt, the appearance of the disease without previous communication with the land or with any other vessel which could transmit the disease; otherwise there would be nothing special in the case. Several vessels are cited on board of which yellow fever appeared at sea; but in verifying the facts it was seen that these vessels had previously been at ports subject to the disease. Such a number of ships traverse the tropic that if yellow fever could develop spontaneously there would assuredly be a great many examples."

Mêlier, inspector general of the sanitary service of France, and the author of the ablest special report on yellow fever ever yet published by a sanitary officer, wrote in 1863 (p. 75) as follows: "Whatever may be the nature of the producing cause of yellow fever—whether miasm or germ, whether cryptogam or infusoria—one thing appears certain, *that the ship is charged with it at its place of departure*, and that thus introduced into the ship it is preserved, probably developed, and concentrated during the voyage, that it is apt to remain more or less latent, while shut up, to reveal itself, sometimes during the voyage, but especially on arrival when the poison is set free by the discharge of cargo."

Dr. A. F. Dutroulau, "premier médecin en chef de la marine," an officer whose unusual ability is proved by his publications, and whose high authority is deferred to by all his associates, had more than twenty years' personal experience, chiefly in Martinique, with yellow fever, under circumstances peculiarly favorable for the observation of infected ships, and in 1868 published the final results of an experience which dated from 1832. His evidence is as follows:† Creditable admission is made (pp. 361, 62) that, since 1832, larger experience had resulted in his case, as in that of so many others, in forcing him to modify his earlier views respecting some of the problems of yellow fever. Having failed to find evidence of personal contagion, he, in 1842, so published, and he was manifestly then disposed to favor the local origin of the disease (p. 436). "But I had my doubts; for I had been struck with the conduct of the epidemic on board of ships stationed in the Antilles during this epoch (1839–1842). To enlighten my doubts I made an investigation, based on the reports made during this time by the chief naval surgeons, and arrived at the conclusions, published in the Gazette Médicale, 1851: First, that the yellow fever had never declared itself spontaneously *one single time* on board of the numerous vessels which had been attacked by the epidemic, and that, since vessels were not attacked until after some sojourn in infected harbors, there was reason to believe that a ship does not, independent of localities, inclose within itself the producing cause of yellow fever." "The same investigation led to the same result in respect to all men-of-war which campaigned or were stationed at Guyana, and in the sea of the Antilles from 1850 to 1857. On *not a single one* was the disease seen to declare itself spontaneously, and before anchoring in an infected harbor; most of them were attacked during their sojourn, or some time after departure; some, more seriously invaded, served as agents for transmitting the poison from one point to another; and these facts, to which attention was awakened, made on this occasion such an impression on everybody that importation remained no longer doubtful to any person" (pp. 436, 437). "Ships traverse all parts of tropical seas without any detriment, provided that they do not touch at unhealthy lands" (p. 173). On pp. 425, '6, '7, Dutroulau gives the following evidence: "In infected places ships receive also their epidemics. Among those in great number, which, during this last period, have been invaded at Cayenne and at the Antilles, there was *not a single one* whereon the disease declared itself spontaneously. The opinion of the physicians in our marine,

*The Hon. S. L. Mitchell, M. D., of New York, strenuously advocated this theory before Congress in 1802, as is stated in the National Board of Health Bulletin of December 11, 1880.

†The facts stated in the preliminary report respecting the evidence of Dutroulau have been publicly questioned; hence, literal translations and references thereto are now given with care, in order that any reader, who may have been induced to suspect me capable of misrepresenting any authority cited by me, may be enabled to determine readily who has been guilty of an act so culpable. It will be found that the evidence is even more precise and emphatic than was represented.

as expressed in their official reports, is *unanimous* on this point; and, as for me, who have had even to prove the erroneous appreciation of the sanitary condition of a port, formed by physicians who pass a little time there during an epidemic repose, *I know* what it is necessary to think about assertions based on absence of yellow fever on land, and what to conclude about the spontaneous development of the disease on board. As to the endemic foci of the Gulf of Mexico and of the Great Antilles, where the cause of yellow fever is permanent, it is not necessary that there should actually be an epidemic there in order that ships there sojourning should find the disease breaking out among the crew. The explanations to which those who believe in the spontaneous generation of yellow fever on ships are forced to resort suffice by themselves for *the rejection* of this doctrine; explanations, which consist in attributing the primary cause of the disease, at one time to the nature of the wood of construction, at another to emanations from the organic matters accumulated in the bottom of the ship, and at another to the fermentative nature of certain kinds of cargo. Why is it that these true causes of general insalubrity have never determined an outbreak of yellow fever during distant East Indian and Chinese voyages, wherein these causes are developed as much as, even more than, elsewhere?" "If the endemicity and the actual sanitary condition of places visited by vessels be well established (for it is from this cause error generally arises), and if the conduct of the epidemic on board be well known, I do not fear to assert that it is always possible to trace the disease to the primary influence of places. This is a truth which dominates the whole etiology of yellow fever, and the *least admissible hypotheses* are in vain substituted to explain, by the spontaneous generation of infected foci born in the ship, the unquestionable facts of importation which some refuse to attribute to the transmissibility of the disease by infection coming from sick persons."

Such is the decisive evidence of Dutroulau, as given, in 1868, in reference to careful observations undertaken as early as 1839. What has been the experience since Dutroulau's report? Cornilliac, a surgeon in the French navy, repeatedly assigned to special duty as sanitary officer for the harbor of Fort de France, Martinique, recorded, in 1873, his experience of yellow fever since 1841. His evidence on the present subject is as follows (pp. 757–'8): "It is observable that when vessels arrive from a healthy place at a port where yellow fever prevails, it is only after a certain sojourn in the latter place, and *when there has been communication with the land*, that the disease breaks out on board." "The immunity which these vessels enjoy during the first days which follow their entrance, an immunity of which the duration—as I was enabled to prove by one year's daily observation of merchantmen—has been 8, 15, 25 and even 40 days in some cases, and never less than 4 days, teaches a fact sometimes contested, viz, that a ship coming from France *cannot be attacked with yellow fever while at sea*, even in a region adjacent to places where yellow fever prevails; and that it is requisite, in order that the disease develop among the crew, that the vessel should touch an infected shore."

As recently as 1878 Bérenger Féraud, "Médecin en Chef de la Marine," on special sanitary duty in Africa as well as in Martinique, and the author of three able works on yellow fever, has recorded his experience. His three works contain more than 340 pages on the etiology and prophylaxis alone of yellow fever. Throughout his works he plainly indicates that the doctrine of the spontaneous origin of yellow fever on ships is too untenable to deserve discussion. This is sufficiently indicated on pp. 502, 503 of "La Fièvre Jaune á la Martinique, 1878."

Dr. Fuzier, a French army surgeon in high official position during that most favorable period for observation, 1861–1866, when France occupied Mexico, and at that most favorable place for observation, Vera Cruz, denies absolutely the spontaneous origin of yellow fever on ships (p. 463, Dutroulau). The evidence of the best authorities among other nations than the French, is, as will now be shown, to the same effect.

Dr. Heinemann, long resident in Vera Cruz, and the able author of the best reports published respecting yellow fever in Mexico, declares (p. 29) that "the fact that ships which have no communication with the land remain free from yellow fever, has often been proved at Vera Cruz." Dr. G. S. Culbreth, surgeon United States Navy, testifies (p. 178, v. 4, 1879, United States Navy Medical Reports) as follows: "It is asserted on good authority that no matter how severe the epidemic in the city [Vera Cruz] the disease never develops in the shipping, except in the persons of those who have exposed themselves on shore. Even during the severe epidemic of 1875, when many sick of the disease were daily transported from the castle of San Juan de Ulua to the city, though passing in close proximity to the shipping, not a case of the disease was developed in the harbor in persons who had not been on shore." Dr. S. T. Trowbridge, United States consul at Vera Cruz, and a resident thereof during the past eleven years, reported to me by letter, in 1880, as follows: "The castle of San Juan de Ulua and the city of Vera Cruz are hot beds for yellow fever. A line drawn from the center of these two points would cross nearly at right angles the harbor or roadstead where the shipping is anchored. Captains of vessels, who keep their men on board and stay

there themselves, *never have yellow fever in their ships.*" "In all the ships which trade at this port I have never heard that any of them have given spontaneous origin to the disease. At all times, even when yellow fever prevails epidemically at San Juan de Ulua and in the city, and when communication is kept up between these points directly, through the shipping, this *remains always free* from the disease, if the men are kept on board."†

Dr. O. S. Vanderpoel, who was for many years the efficient and distinguished quarantine officer for the port of New York, and who had probably as large experience with infected vessels as any other living man, declared (pp. 262–3, Trans. Medl. Socty. State of N. York, 1874), that "the tenacity of the poison in a ship has given argument for the spontaneous generation of yellow fever. But it really serves to prove how tenacious of life the germ is when in a favorite nidus." Dr. A. S. Gihon, surgeon and medical inspector, United States Navy, has testified (p. 375, v. 4, 1877–'78, Trans. Am. Public Health Assn.), "I desire to put on record the experience, and the opinions based on that experience, of the medical officers of the Navy, which I am here to represent, by the authority of the Surgeon-General of the Navy—I believe them to be their unanimous opinions; if there are any dissenters I have never met them: 1. The yellow-fever ship is always a foul ship. 2. Foul ships, while often generating by their filth other endemic diseases, *have never developed yellow fever de novo.*"†

Those who will read the admirable report of yellow fever in Jamaica, by Dr. Donnet, deputy inspector-general of the British navy, published in the health report of the British navy for 1867, will find that he gives no countenance to the spontaneous origin of yellow fever; and on pp. 113, 123 of this same health report, it is reported, as to the "North American and West India station," that, of a fleet of 25 vessels, 8 became infected with yellow fever, and that not only in those, but in all vessels infected on this station during the past seven years, as observed by the reporting surgeons, the disease was easily traced to infected places on land. Aitken (p. 440, v. 1), referring to the report of the infected Icarus, as reported by its surgeon, Dr. Macdonald, F. R. S., states that he thereby proves that "as with typhus and typhoid fevers, so with yellow fever, the doctrine of its spontaneous origin can have no foundation to satisfy the rational mind." It would be a work of supererogation to cite the numerous illustrious British authorities to the same effect.

In addition to other evidence, it is a fact of very significant importance that the owners, agents, and captains of vessels engaged in constant voyages within the region frequented by yellow fever, have no fear of the disease except when touching at infected ports, and even at most of these feel secure, provided they can succeed, as all generally strive to do, in keeping their men from visiting the shore. Thus, the ordinary daily experience (extending through centuries) of non-professional men has taught them the practical lesson, that they need have no fear of the spontaneous generation of yellow fever in ships.

While no one was seen or heard of in Cuba, who advocated this doctrine, many eminent men, some of them physicians, were found, who, as will be seen in the report of Colonel Albear (Chapter XXII), were converts to an offshoot of this doctrine, inasmuch as they believed that yellow fever in Havana was fostered more particularly in the harbor, especially in the foul, offensive water thereof. This belief is termed an offshoot of the old doctrine, because a harbor is a mere offshoot of the ocean. Whether yellow fever be an "oceanic" disease, or a disease of harbors, in either case, there is attributed to the sea water, inclosed within certain terrene boundaries, an influence superior to that of the land forming said boundaries. If any such predominant influence is exercised, this ought to be manifest irrespective of the distance from the land; and, outbreaks of yellow fever, on ships, very surely ought not to increase in frequency with diminution of the distance from the land. Should facts demonstrate that the risks of infection incurred by vessels always decreased with their distance from, and increased with their proximity to, the shore, no doubt could remain that the infecting poison was located on the shore, and neither in nor upon

* The fortress, San Juan de Ulua, is built on a reef opposite Vera Cruz, and the distance from shore to shore is about 3,100 feet. The anchorage ground lies between. The water-front of the fortress measures about 500 feet, and of the city from one to one and a half miles. The anchorage ground is 450 to 600 feet wide, and about three-quarters of a mile long; and the center thereof is some 800 feet from the fortress, and, of course, much further from the city. The distance at which vessels anchor from the shore, the free exposure of the roadstead to the winds, and the less communication with the land are probably the causes why vessels at Vera Cruz are much less frequently infected than at Havana. It is alleged that vessels subjected to proper precautions never become infected at Vera Cruz.

† However, it seems that Dr. T. Woolverton, Surgeon, U. S. N., was a dissenter, since he reported that the yellow fever on the U. S. S. Plymouth, in 1878, "had a purely local origin inherent in the ship." He advocated this theory in spite of the facts, that the Plymouth had touched at habitually infected ports every year since 1872; that it had on board numerous stores marked "Rio Janeiro"; that Dr. Moore, Surgeon, U. S. N., gives warning, p. 179, V. 5, An. Repts. Surgn. Genl. U. S. Navy, that the U. S. Naval storehouse at Rio Janeiro is most unfavorably located, and that its stores are dangerous fomites; and that the Plymouth had coaled at St. Thomas, where there were cases of yellow fever only ten days prior to the outbreak on board. The sanitary board, subsequently appointed by the Surgeon-General, U. S. N., to thoroughly investigate the subject, refuted Engineer Woolverton and sustained Dr. Gihon's view.

the water. Special investigations, prompted by these views, were undertaken in Havana, and the results will now be stated.

Dr. De Caneda, a distinguished medical officer of the Spanish navy, long stationed in Havana, and the president of the Spanish commission, incidentally wrote, August, 1879, in an interesting report, not on this special subject: "It is frequently observed that the first cases on board ships of the Spanish squadron are of those persons whose duty calls them oftenest to the shore."* Dr. De Caneda appointed Surgeons Soler, Medina, and San Roman, from the naval sanitary corps at Havana, as a special commission to report on the questions propounded by Dr. Chaillé, president of the United States Commission. Their valuable report contains the following: This commission "is of the opinion that of the individuals of the navy, stationed in Havana, those most liable to contract yellow fever are those who inhabit the arsenal, and who frequent the wharves"—"the farther the vessels are anchored from the wharves the less their danger of being attacked by yellow fever"; and the members regret they have not sufficient time to collect statistical facts in detail "to demonstrate, beyond question, the truths stated and derived from their personal experience and judgment."

Fortunately that able and zealous officer of the United States, Dr. D. M. Burgess, who had been earlier notified of the report desired by this commission, was enabled to collect statistical facts in detail and to present a very valuable tabular statement of these facts. The interesting letter which accompanies the table instructively summarizes the results, and will be presented in full, prior to the table, after one necessary explanation. Dr. Burgess, as well as the United States Commission, designated a vessel having one or more cases of yellow fever on board "infected," but both parties were well aware that while such a vessel should be regarded in practice as infected, yet it cannot, with rigid scientific accuracy, be so proved unless cases have developed on board within the time—say six days—since those attacked had opportunity to become infected by some place, thing, or person outside the vessel.

"No. 2 Tacon Street, Havana, Cuba, *October* 4, 1879.

"Stanford E. Chaillé, M. D.,
"*President of the Havana Yellow Fever Commission, &c.*:

"Dear Sir: Your communication soliciting answers to the following questions in regard to the infection of vessels by yellow fever, while lying in the harbor of Havana, is received. In reply I would say that since definite statistical data are very much wanting on this subject, more credence is asked for personal experience and observation than would be otherwise desirable.

"First question: 'Which vessels are more apt to be infected, those at wharves or those at anchor?'

"Twelve years of constant professional intercourse with, and observation of shipping while lying in this harbor, convince me beyond all question that those vessels which lie at wharves suffer incomparably the most. Even in winter, when no cases of the disease can be found on vessels anchored in the open bay, and which do not permit their crews to go ashore, it is not at all unusual to find that vessels lying at wharves are invaded by the disease. In the summer months vessels which discharge at wharves nearly all become infected, as a reference to the facts relating to the infection of the vessels in this harbor, recorded in the accompanying table, will verify. In this, it will be seen, that of thirty-one vessels which discharged at wharves during the months of July, August, and September, 1879, twenty-eight became infected, only three escaping. One of the latter should be thrown out of the calculation, as its whole crew were acclimated. Thus it will be seen that only one vessel in fifteen at the wharves during these three months, escaped infection.

"Second question: 'Which vessels are more apt to be infected, those at anchor near the shore, or those more distant?'

"All of my observation, as well as the facts recorded in the accompanying table, sustain me in the assertion that the liability to infection in this harbor is in an inverse ratio to the distance at which a vessel lies from wharves and habitations. It will be seen in the table that out of nine vessels lying at short distance from whaves five became infected, or a little more than 50 per cent., while of the eleven vessels which lay at greater distance out in the open bay only two became infected, or not quite 20 per cent. One of these two vessels had a crew of twenty-two unacclimated persons, only two of whom were attacked, one being the captain, who frequented the shore, and the other the steward, who never went ashore. The other one of the two vessels had a crew of twenty-eight unacclimated persons, and none went ashore except the captain; two had yellow fever.

*Dr. De Caneda, having been subsequently solicited to state more explicitly "what was the experience of the medical corps of the Spanish navy, respecting the spontaneous origin of yellow fever on ships," replied, from Havana, August 2, 1880, as follows: "For thirty years I have been on duty in the Spanish navy, and during this long period I have never seen a single case of this disease appear on board a vessel, unless the vessel had either touched at, or had received on board cargo or some materials from some infected place. In my opinion, yellow fever cannot originate spontaneously."

"Attention is called to three vessels, viz, the Antonio Sala, the Skerryrore, and the Lisbon, which entered this harbor on the same day. The first two anchored, discharged, and loaded in the open bay, and on the nineteenth and fifteenth day afterwards sailed away without becoming infected. The Lisbon went to the wharf called San Francisco, to discharge, and three days afterwards began to have some cases of yellow fever on board, and soon all on board, eight in number, had the disease severely. This is a striking instance of the difference in the chances of infection, when making comparison between the wharves and the open bay.

"Third question: 'Which vessels are more apt to be infected, those at anchor near to Havana, Regla, Casa Blanca [centers of population], or those at anchor equally near the shore, but more distant from habitations?'

"I am laboring to secure more definite data in regard to these points but have no hesitation in saying that the nearer a vessel is to wharves and to habitations, the more it is exposed to infection. Thus, it has been shown that vessels are far less likely to become infected in the open bay, distant from wharves and habitations; but it should be remembered that one strong element in causing this comparative exemption is undoubtedly due to the limited intercourse which the crews of vessels so situated are permitted to have with the shore.

"Much and long-continued observation, with statistical records, are very desirable on all of these points, never forgetting to note the number of acclimated and of unacclimated persons aboard of each vessel.

"Very respectfully, yours,

"DANIEL M. BURGESS, M. D.,
"*Sanitary and Quarantine Inspector at Havana, of*
"*the United States National Board of Health.*"

TABLE No. 12.—*Statement of all foreign vessels entering and lying in the harbor of Havana more than six days during the months of July, August, and September, 1879, and statement of relative infection with regard to their anchorage.*

Nationality.	Class.	Name.	Date of entrance.	Time in harbor.	Location in harbor. Wharf. Infected.	Wharf. Not infected.	Short distance from wharf. Infected.	Short distance from wharf. Not infected.	Open bay. Infected.	Open bay. Not infected.	Remarks.
			1879.	Days.							
British	Bark	Enchanter	July 1	25	Yes						
American	Brig	Sparkling Water	July 1	23	Yes						
British	do	Five Brothers	July 1	29	Yes						
"	Bark	Madras	July 2	65			Yes				Near Muelle (or wharf) de Feliciano.
American	do	Norton Stover	July 2	25	Yes						
	Schooner	T. H. Lancaster	July 2	31	Yes						
British	Steamer	Alnwick Castle	July 2	18					Yes		No one permitted ashore but captain; crew 28 persons unacclimated; 2 had yellow fever.
American	Brig	David Owen	July 3	30	Yes						
	Schooner	Theresa G	July 4	9						No	
British	Bark	Troas	July 11	20	Yes						
	do	Troch Rague	July 14	41			Yes				Near Muelle de Feliciano.
	do	Caspian	July 15	25	Yes						
American	Schooner	Daybreak	July 16	17			Yes				300 feet from wharf; first from Ponton.
	do	Etta A. Stimpson	July 18	22	Yes						
	Bark	L. T. Stocker	July 20	37	Yes						Discharged at Muelle Feliciano.
	Brig	Havana	July 21	16	Yes						
	Bark	Elba	July 21	19	Yes						
	do	Devonshire	July 22	39	Yes						
British	do	Alaska	July 23	31	Yes						
American	Schooner	Fanny R. Williams	July 24	25		No					
	do	Imogene Diverty	July 25	14	Yes						
British	Bark	Black Prince	July 27	25	Yes						
American	do	Ann Elizabeth	July 27	43	Yes						
	Brig	Agnes Barton	July 30	14						No	Discharged ice in front of ice-house.
	do	Fanny H. Jennings	July 31	33	Yes						
	do	Wm. H. Genn	July 31	21	Yes						
	Schooner	White Wing	July 31	25							Crew all deserted.

TABLE No. 12.—*Statement of all foreign vessels entering and lying in the harbor of Havana, &c*—Continued.

Nationality.	Class.	Name.	Date of entrance.	Time in harbor.	Location in harbor.						Remarks.
					Wharf.		Short distance from wharf.		Open bay.		
					Infected.	Not infected.	Infected.	Not infected.	Infected.	Not infected.	
			1879.	*Days.*							
American	Brig	Ada F. Crosby	Aug. 1	35		No					Crew composed of colored men.
	Bark	Acacia	Aug. 1	25	Yes						Discharged Muelle Feliciano.
	Brig	Lise Houghton	Aug. 2	42	Yes						
German	do	Carl Graffattems	Aug. 2	33	Yes						
American	do	Stockton	Aug. 12	39	Yes						
	do	S. V. Merrick	Aug. 19	33	Yes						
	do	Clara J. Adams	Aug. 19	36	Yes						
	do	F. J. Merryman	Aug. 21	40				No			300 feet from wharf; second from Ponton.
	do	C. C. Robinson	Aug. 21	40		No					Crew all acclimated.
British	Bark	Prince Rupert	Aug. 21	20					Yes		22 of crew unacclimated; captain much ashore; dissipated, and died of yellow fever. Steward not ashore; had yellow fever; the only two cases.
	Brig	Lochiel	Aug. 21	11	Yes						
American	Schooner	Wm. Wilson	Aug. 23	38	Yes						
British	Ship	Prince Rudolph	Aug. 24	25						No	21 persons unacclimated.
American	Schooner	Theresa G	Aug. 30	12						No	
	do	Sarah Hall	Sept. 5	19			Yes				200 feet from wharf near Ponton.
	Bark	Antonio Sala	Sept. 12	19						No	
	do	Lisbon	Sept. 12	19	Yes						
British	do	Scarryvore	Sept. 12	15						No	
American	Schooner	L. B. Wing	Aug. 18	18				No			300 feet from wharf near Ponton.
	do	Daybreak	Sept. 16	14			Yes				250 feet from wharf near Ponton, and crew allowed ashore.
	do	Manántico	Sept. 19	12				No			200 feet from wharf near Ponton; crew not allowed ashore.

British	Brig	Five Brothers	Sept. 20	10				No		
American	Schooner	L. M. Knowles	Sept. 20	10						No
	Brig	Merriwa	Sept. 21	8						No
	....do	Hyperion	Sept. 24	7						No
		Total (52)			28	3	5	4	2	9

DANIEL M. BURGESS, M. D.,
Sanitary and Quarantine Inspector at Havana of the United States National Board of Health.

Dr. Burgess has continued his observations, and has kindly forwarded a tabular statement of 368 additional vessels inspected by him since the date of the preceding report and to May 1, 1880, that is, during the seven months, October to April, when the danger of infection is least. Of these 368 vessels, 152 remained in port less than five days, and none were infected. Of the remaining 216 vessels, there were 96 that were anchored in central parts of the open harbor, therefore distant from the shore, and it deserves special notice that not one of these became infected, although 35 of them were anchored in the harbor more than 15 days, and several of them for more than 50 days. In addition to these enumerated vessels, none of which were Spanish, Dr. Burgess reports, "Some Spanish vessels at wharves have suffered from yellow fever during October to May, but I am unable to learn that any of those anchored in the harbor suffered, and am certain that none of the vessels of the Spanish navy did. While vessels in the open harbor have enjoyed freedom from invasion, certain localities in the city have suffered from yellow fever all the winter."

The remaining 120 vessels were all at the wharves, or within less than 100 feet thereof. Fifteen of these, that is, one in every eight, became infected, eight of them in October and November, and one or more in every one of the seven most favorable months, except February. Dr. Burgess adds, "The shortest time which elapsed between the entrance of any of the fifteen vessels and their attack by yellow fever was seven days, and this occurred in one instance only; all the rest were in port more than ten days before becoming infected." "Eleven of the fifteen infected vessels were lying at wharves of notoriously bad sanitary condition, having sewers emptying under them, &c., and two of said wharves are on either side of the arsenal, and of the adjacent military hospital, places always infected. The remaining four were very near to wharves, which are peculiarly situated in a nook of the bluff on which Fort Cabañas stands; into this nook two sewers from the crowded fort empty, and it is cut off from the winds which might drive away the poison; yellow fever attacked nearly every vessel which anchored in this nook during the whole summer of 1879, and it was undoubtedly an infected place."

Since the report of the above facts to May 1, Dr. B. reported August 5, 1880, "I am confident that not one merchant vessel in this port, from May 1 to August 1, has been invaded by yellow fever, except in case the vessel had been at some wharf. Of the vessels at wharves about twenty have been attacked."* All the facts reported by Dr. Burgess conclusively demonstrate that the water in the open harbor of Havana is not, as is there supposed, especially dangerous, and that the danger is confined to the shore. Of the total 420 vessels now reported by name and in detail, 50 have become infected, and all have illustrated that the danger increases with proximity to the shore. During the year which closed on July 21, 1880, more than 500 vessels had been carefully watched, and not one had given rise to even a suspicion that it generated the poison. If vessels are endowed with this marvelous power, where, on the globe, could they find conditions more favorable to make this power manifest than in the harbor of Havana? Is the alleged power held in abeyance, as are spiritualistic manfestations, during the time when a competent inspector is on guard?

While all the evidence and all the facts thus far presented are deemed conclusive against any such incredible generative power, the following facts tend not only to strengthen this conclusion, but also to throw light on the mooted question, what can and should be done to render the harbor of Havana less dangerous?

The town of Sagua, with a population of 18,553, is about ten miles from its roadstead, which is a part of the open sea inclosed by islands, and so shallow that vessels anchor several miles distant from the shore. These vessels very rarely, if ever, become infected. The harbor of Cardeñas measures some twelve by eighteen miles; vessels are compelled to anchor from one-half to two miles distant from the shore, and in this harbor also the infection of vessels is exceedingly rare—as was the case even during the summer of 1879, when Cardeñas suffered with its severest epidemic. The harbors of Matanzas and of Cienfuegos, elsewhere described, are much less spacious than the two just mentioned, but much more spacious than the harbor of Havana. A much smaller number of vessels are at wharves, a comparatively larger number are anchored at a distance from the shore and from densely inhabited parts of these towns, and these absolutely less numerous vessels are anchored at greater distance from each other than at Havana. It is difficult to escape the conclusion, that it is owing chiefly to these differences that, while vessels at Matanzas and Cienfuegos are much more frequently infected than at Sagua and Cardeñas, they are much less frequently infected than in the much smaller harbor of Havana.

These facts are also at variance with the origin of yellow fever on ships, and the above conclusion from these facts justifies the following additional deduction: Since man could not render the harbor of Havana cleaner than are the harbors of Matanzas and Cienfuegos, nor by artificial canals renew the water in the former to the extent

* May 2, 1881, Dr. Burgess again reported that he had then inspected 1,079 vessels, that 604 of these had been in port 5 days or more, and that "in not one of them all has there been any evidence of the spontaneous generation of yellow fever on board."

that nature renews the water in the two latter harbors, the cleansing of the harbor of Havana and the constant renewal of its water, however desirable, would not prevent the infection of the shipping at this port. The facts now presented, and all others known to me, tend to prove beyond question that the poison of yellow fever is on the shore, and *not in the water of the harbor*. The conceivable but in large measure impracticable remedy best calculated to diminish those dangers of infection due to any special defects and peculiarities of this harbor would be, to so deepen its shallows and enlarge it that vessels could anchor at much greater distance from the shore and from each other.

There is a final deduction of much scientific importance derivable from the conclusion that yellow fever never originates on ships. This deduction will be better understood if preceded by the statement, that the facts occurring within an infected place and bearing upon the questioned transmission of yellow fever can be as well explained by infection of locality as by infection through the movable things and persons in such locality; and that, therefore, these facts as they occur outside of habitually infected localities must be more particularly relied on to solve the question. Now, vessels, because of their restricted limits and of their small and more readily observed contents and population, are the places which present the most numerous and favorable opportunities for the solution of all questions which relate to the modes by which the poison is conveyed to such places, as well as from thence to other places, and also to the conditions necessary for the propagation of the poison.

On the proper study of these questions it greatly depends whether our present knowledge of the means to prevent yellow fever is to halt or to advance. Medical men of the greatest ability and scientific zeal are needed to prosecute this study in localities where opportunities constantly abound. If the right men were kept as United States sanitary inspectors in the right places thus to pursue this study, results tending to preserve the health and lives of millions of human beings and to foster the commercial prosperity of many great cities might be confidently expected eventually to ensue.

Finally, while yellow fever never did and never will originate spontaneously on ships, yet it continued, throughout the long period of time during which ships were the chief vehicles of transportation from infected places, to be, in a certain sense, a "nautical," "oceanic," and "sea-port" disease; but with the invention of steamboats, it in the same sense became a disease of towns on navigable streams, and with the invention of railroads, it became a disease of inland railroad depots. Hence, though ships continue, for obvious reasons, to be the best carriers of yellow fever, this is no more a "ship disease" than it is a steamboat or a railroad disease; and no more an "oceanic disease" than it is a fluvial, riparian, or inland disease.

CHAPTER X.

ACCLIMATIZATION, OR ACQUISITION OF IMMUNITY FROM YELLOW FEVER.

The more frequent and intense the prevalence of yellow fever in a place, the firmer and more general is the conviction that the natives enjoy an immunity from the disease; hence, in Cuba, this conviction is specially well marked. Much evidence was there gathered by the writer on this subject, and, with the presentation of some of this evidence, effort will be made to correct some prevalent errors, and to gain a somewhat clearer insight into the causes of this alleged immunity. In the mean time, it is fully recognized that science does not yet possess sufficient premises to justify conclusions as absolute as are generally credited on some of the points involved, that further investigations must be made to solve these, and that our present deficiencies are chiefly due to our inability to diagnose yellow fever with certainty, especially the milder cases.

These two questions will be considered: Do the natives of Cuba enjoy immunity from yellow fever; and, if so, to what causes is any such immunity due?

Dr. J. R. de Armona, one of the many accomplished physicians of Cuba, wrote September 23, 1879: "I disagree with my confrères in Marianao or elsewhere, who believe they have seen yellow fever in native Cubans, much less in children. I believe all such cases to have been remittent bilious fever." This quotation will suffice as a representative example of present opinion in Cuba both in and out of the profession. None the less, it is believed that the following evidence will serve to prove that this prevailing opinion is entirely too absolute, and that only those Cubans born and resident in places where they are habitually subjected to the influence of the poison, enjoy, to any great extent, this apparent immunity. The record of this evidence is the more important now, because if yellow fever should continue to increase in Cuba, the difficulty of establishing the truth will annually augment, for, the more frequent, violent, and wide-

spread the disease, the smaller the number will become of those who will appear to be susceptible.

Humboldt, writing in 1800–1804, says (p. 117, Thrasher's Humboldt): "The sea-shore has such an influence, that even the natives of the island who reside in the country, far from the coast, are subject to attacks of yellow fever when they visit Havana." While no doubt is entertained of the correctness of Humboldt's testimony as to the liability of Cubans living in the country, and the passage is cited solely as one proof of this in 1800, yet, Humboldt probably never wrote a sentence which contained a greater error than in attributing a special influence to the sea-shore. This once wide-spread error is still propagated by Dutroulau and other high authorities, and therefore will justify a brief diversion from the topic in hand, to refute it. It is often associated with another error, viz., the combined influence of salt mixed with fresh water in favoring yellow fever; and it has even been urged, in other countries than Cuba, that a malign maritime influence can travel by winds to places far inland. However, in Cuba, it is impossible to get in any part thereof as far as 70 miles from the sea, while the general average width of the island is only about 52 miles.

The locality of maritime cities generally is, for reasons well understood, at the mouths of rivers. Ships frequent maritime cities, and if infected ships are the best carriers of the yellow-fever poison, then there is no need of "a sea-shore influence," nor of "mixed fresh and salt water," to explain why the poison is most frequently imported into, and thereby more frequently gets a foothold in maritime cities. Until the present century, ships were the most rapid traveling conveyances, and were especially superior to inland conveyances, as to the confined air and filth transported in their holds, and therefore it is not strange that, until this century, the maritime tropical cities, most frequented by infected ships, were the places most frequented by yellow fever. Early in this century, steamboats were added to our traveling conveyances, and then, for the first time, yellow fever began to manifest a greater inclination for inland towns, located on or adjacent to the banks of such streams as the Mississippi River, plied by steamboats from such infected centers as New Orleans. More recently, railroads have been built, leading from such cities as Vera Cruz and New Orleans; succeeding the opening of such roads yellow fever has repeatedly manifested the new inclination to visit inland places on these roads, very much farther from the sea-shore, from the banks of rivers, and from mixed fresh and salt water, than it is possible to get even in the uninhabited mountain lands of the widest part of Cuba. These are facts, which no one, if familiar with no more than the history of yellow fever in the Mississippi Valley in 1878, can possibly dispute, however disputable may be their explanation.*

While great maritime cities are more apt to become infected because of more numerous importations, it is now well known that yellow fever may ravage the most insignificant hamlet, even the scattered huts of a plantation. Hence the influence of the sea-shore should manifest its malignancy, not only in all such cities, but also in less populous places. So far is this from being true, that there are many indisputable facts to the contrary.

The Isle of Pines, Bahia Honda, Cabañas, Mariel, Zaza, and other pre-eminently maritime places in Cuba suffer little, if at all, with yellow fever. Heinemann and others report a number of places on the Mexican coast, at the mouths of rivers, and located between Vera Cruz and places south thereof which habitually suffer with yellow fever, and yet these intervening places, though visited annually by the unacclimated foreign seamen of vessels, which do not touch at Vera Cruz or other infected place, have never yet suffered from yellow fever. The whole southern sea-coast of the United States from Mexico to New York can present innumerable settlements which have suffered either never or very rarely, though located between places which have repeatedly been attacked. Boudin's Medical Geography asserts, with truth, that all notoriously fatal harbors have close by them, on the sea-shore, as well as inland, healthy places free from yellow fever. Finally, it is not to be forgotten that in the eastern hemisphere there are a number of large tropical cities, such as Calcutta, Bangkok, Saigon, Canton, and Borneo, not only on the sea-shore, but at the mouths of rivers; and that, none the less, these have never yet been visited by yellow fever. Is it possible to credit, that although these cities are built on soil of the same geological character as in the western hemisphere, washed by the very same earth-encircling ocean, and warmed by the same sun, they owe their exemption from yellow fever to some incomprehensible

* There were, in 1878, cases and deaths of yellow fever reported, from 132 places in the United States, to the Congressional Board of Yellow Fever Experts, of which I was a member and the secretary. With very few exceptions, these 132 places were immediately on navigable waters or on railroads, and not one of these exceptional places was more distant than 10 miles from river or railroad. In not less than 98 of the 132 places, cases occurred among those inhabitants who had not been elsewhere exposed to infection; of these 98 places, 9 were on navigable waters and on railroads, 31 were on navigable waters only, and 58 were on railroads only.

A limited section of Louisville, Ky., which is about 600 miles from the sea, and 755 miles by rail from New Orleans, was evidently infected by means of the railroad; and a localized outbreak also occurred, evidently by means of the steam tow-boat Jno. D. Porter, at Gallipolis, Ohio, 1,760 miles from New Orleans, via the Mississippi and Ohio Rivers. Numerous inland localities between Louisville, Gallipolis, and the Gulf of Mexico were infected in 1878, as also in preceding years.

difference between the Asiatic and American sea-shore, rather than to their distance from and little communication with the American centers of infection? The poison of yellow fever is certainly much more sensitive to cold than is the poison of cholera, and if it be admitted, as seems certain, that the former is more difficult to transplant than the latter, then it becomes possible to understand why Asiatic maritime cities should not yet have suffered at all with yellow fever, while American sea-ports suffer comparatively little from cholera. Any other view leads to inexplicable mysteries. In fine, Cornilliac is one of the few who correctly teaches that "sojourn on the sea-coast does not render the European less apt, as has been pretended, to contract yellow fever"; nor does it, *per se*, render the creole native less apt. Farther, while sea-shore towns have been more frequently infected than inland towns, this has been due, not to the special influence of the sea directly on the disease, but to the fact that the commercial cities, which are frequented by vessels, the best transporters of the poison, and are incessantly resupplied with inhabitants susceptible to that poison, are located on the sea-shore.

Returning from this digression, the evidence as to the liability of Cubans to yellow fever will now be resumed.

In 1822, Dr. José F. de Madrid, of Havana, wrote: "Fortunately the natives of the city and the acclimated enjoy a happy immunity. Only the rural inhabitants occasionally suffer with the fever."

In 1830 Dr. P. S. Townsend, of Havana, wrote: "So, also, as is familiarly known at Havana and other places, do those more robust and healthy natives of the interior of Cuba, when they come in the summer from their plantations to visit or reside among their pale, languid, and sickly brethren of the sea-port, too often perish with the black vomit under its most appalling form." (P. 325, N. Y. Med. Jour., 1830.)

Peñuela wrote in 1855 (Topog. Med., p. 275): "The tradition of Holguin does not record the existence of any epidemic disease, and yellow fever had never manifested itself in this jurisdiction. However, at the beginning of the year 1851, according to Dr. Cañizares, a regiment arrived from Havana with the germs of both cholera and yellow fever, and these two epidemic diseases at the same time ravaged not only the troops but also *the natives of every sex, age, and condition*, presenting the rare example of two epidemics appearing, coexisting, and terminating exactly the same, and uniformly." Peñuela (p. 269) also records the liability of the natives of the jurisdiction of Manzanillo, and "particularly of the children," to yellow fever.

Drs. Elcid and Dumont reported, in 1867, a yellow fever epidemic in 1865 at Recreo, on the railroad, about 14 miles southeast of Cardeñas (pp. 89–103, V. 4, Anales). Dr. Elcid, who had had a long experience with yellow fever in the military hospital at Havana, and whose competency was indisputable, was an eye witness to this epidemic. These reporters testify that creoles raised on plantations, and who visit Havana, Matanzas, and Cardeñas, often contract yellow fever and die, and that at Recreo, in 1865, many native Cubans did die with unquestionable yellow fever. Of some of these the names, decisive symptoms and other details are specified. All the physicians, pharmaceutists, and the entire population were unanimous in their belief that the disease was yellow fever. Drs. D. and E. state that, although the Cuban superior board of health had denied the possibility of the existence of the yellow fever epidemic at Colon, as reported by its resident physicians, yet that this epidemic at Recreo conclusively disproved the position of the superior board of health. "As during the epidemic at Colon, so we find at Recreo, the eternal diagnostic conflict between yellow and bilious remittent fever. Efforts are everywhere made to restrict the dominion of the former in favor of the latter. Fear and interested motives find their efforts successful at the expense of truth." "It is certainly true that epidemics of yellow fever do occur in the interior of Cuba, which attack individuals there acclimated; it is also true that yellow fever in the interior of Cuba and in the Antilles may attack the creoles themselves; and it is further true that a differential diagnosis between yellow and bilious remittent fever can, very certainly, not be made by the fact that a creole is attacked, and therefore that yellow fever is excluded." In 1879, it was still common in Cuba for a physician, in presence of all the symptoms of yellow fever, to declare, if the patient were a creole, that his disease was not and could not be yellow fever.

In 1874, Dr. R. H. Poggio, medical director of the military hospital at Cadiz, a member of the Academy of Sciences at Havana, and formerly medical director of the Havana military hospital, wrote as follows (p. 59, Acclimation and Hygiene of Europeans in Cuba): "The want of sufficient data respecting the endemic diseases of Cuba has permitted the belief to exist that the native Cubans enjoy an immunity from yellow fever. But an attentive and unprejudiced observation of the disease during the recent years of war and disturbance has rendered very manifest the fact that Cubans, from their birth to an advanced period of life, and their descendants—inhabiting the interior of the island—are liable to yellow fever, when removing from such localities to others near the coast, and that the disease is as deadly among them as among Europeans. I have observed these facts not only near the sea, but in the interior of Cuba. In the jurisdiction of Bayamo I have seen die with all the symptoms of yellow fever not only the

inhabitants of Guisa [about 15 miles southeast of the city of Bayamo], situated on an elevation, and reported to be one of the healthiest localities in the jurisdiction, but also negro slaves who served in the army. Like facts have been observed by many eminent physicians who have practiced medicine in Cuba, and in other countries where yellow fever is endemic. In the archives of the Havana Academy of Sciences a great mass of data are collected to confirm the facts that both white and colored do fall victims to yellow fever as well as to intermittent fevers, and are not naturalized or habituated to these, notwithstanding that they have been born in Cuba, and have been constantly subjected to its climatic influence." Dr. Poggio is unquestionably correct in stating that the facts observed during the insurrection, 1868–1878, when thousands of countrymen were forced to take refuge in infected sea-coast towns, did serve to convince many that all Cubans were not exempt from yellow fever; but he is wrong in stating that inhabitants of the interior had only to visit "localities near the coast" in order to be attacked, for if uninfected localities on the very sea-coast be visited, these are no more dangerous than any other uninfected localities. It is also quite certain that he goes too far in asserting that the class of Cubans who are liable to yellow fever are just as liable as Europeans. He may be right, but neither he nor any one has yet gathered and presented proofs of this.

Dr. Pedro Imanes, of Baracoa, officially reported to the Spanish Yellow-Fever Commission that in the epidemics at that place in 1876–'78 an "exceptional feature was that it attacked with special vigor and fatality native Cubans," not only natives of the town, but also of the adjacent country; and that, "as is well known, native residents of the adjacent elevated country are as liable as Europeans to the disease." Taken in connection with Dr. Imanes's further statement that no epidemic had occurred for very many years prior to 1876, the "exceptional feature" reported by him failed to be at all exceptional; on the contrary, all yellow-fever places illustrate, as a general rule, that the longer the disease is absent the greater is the number of the natives attacked. In fact, this is a decisive test as to whether the poison has or has not been habitually present.

Dr. Lucas Gallerdo, of Gibara, officially reported, August, 1879, in respect to this Cuban sea-port: "I have attended numerous cases of yellow fever in residents of this town who had never left it. Among these were some cases of children four years old and upwards. Every summer I have attended cases of yellow fever in natives of the adjacent country who had never left their places of residence."

In 1879, official reports from resident physicians and boards of health in Guantanamo, Remedios, Sancti Spiritus, Trinidad, and various places in Cuba, besides Baracoa and Gibara, united in testifying to the liability to yellow fever of native Cubans, residents of the country adjacent. Cardeñas suffered with its worst epidemic of yellow fever in 1879; and in reference to it the Cronica Med. Quir. of Havana published, in September, 1879, this very significant sentence: "Besides the ravages of the endemic, *bilious fevers have had victims, especially among children and youths.*"

While in Cuba, I gathered from eminent physicians a number of cases of yellow fever in Cubans not only born but always residing in Cuba, so well described and authenticated as to leave no doubt as to the true nature of the disease. It is deemed sufficient as to these individual cases simply to refer to Drs. Forns and Morado, of Marianao, and to Drs. Zayas, del Valle, and Burgess, of Havana, all physicians of note.

But, in this connection, evidence of so much interest was presented, directly to the commission, by Drs. Reyes, Selsis, Navea, and Mazzarredo, that it deserves record. These gentlemen are all physicians of age, experience, distinction, and superior education; all, except perhaps Dr. Navea, are graduates of Paris.

Dr. Reyes writes: "Children have always been considered little liable to yellow fever intoxication. Some children from the interior coming to Havana may suffer as such adults do; but, if so, rarely." "I do not refuse to credit the occurrence of yellow fever in children, because, for the last two or three years, I have heard, particularly during the summer, of epidemics of an undefined hemorrhagic fever which has killed many children. Two years ago many children thus died at Colon, Sagua, and Cardeñas. I am the slower to form a conclusion in the matter because accurate scientific observation here, especially in country places, is still in its cradle. This undefined fever has also existed in Havana this summer (1879), for there have occurred quite a number of deaths among children by a hemorrhagic fever." Dr. Reyes details one of these cases of a Cuban child five to six years old, and says that the death in this case was attributed, "of course, to the always-prophetic bilious fever."

Dr. Selsis, now of Havana, but long at Santiago de Cuba, writes: "Cubans born in and residents of the interior, especially of the cool and mountainous parts, are liable to yellow fever." "I have never seen a case of yellow fever in any one born and living in Santiago de Cuba, but I have seen at Havana several cases of well-marked yellow fever in young subjects who had never left the city. Dr. Argumosa, jr., with Drs. Albertini and Redondo, in consultation, had one such case in a child twenty-seven months old, who died with unquestionable yellow fever. This deserves the more attention because in an adjacent village there has been for some time the question as to

the existence of a Cuban yellow fever." Dr. J. V. Castro, of Havana, has reported that in August, 1880, one of his own children, aged 5 years, suffered certainly, and three others probably, with yellow fever in Havana. These children were born and had, for the most part, resided in the jurisdiction of Sagua la Grande, and their grandparents, as well as their parents, were native-born Cubans. Dr. Castro testifies that Cubans from the country, or long resident abroad, frequently suffer with yellow fever when exposed to infected places.

Dr. Navea, of San José de las Lajas, an inland town some 20 miles southeast of Havana, presented the following interesting report, after it had received the full approval of Drs. Cabrera and Bofil, his colleagues at San José: "We have here, annually, in the practice of the three physicians from 20 to 30 Cuban children, and from 30 to 40 Cuban adults attacked with bilious remittent fever, which is popularly designated typhus. There is nothing whatever to constitute a differential diagnosis between this fever of the natives and the yellow fever of strangers. It is characterized by its hemorrhagic tendency, albuminuria, black vomit, and all the symptoms of yellow fever. It is so well marked that even when seen by the uneducated they exclaim, 'Vomito.' The treatment for the one is the best for the other. We have never seen a second attack of this bilious remittent fever, nor one who had recovered from it attacked with yellow fever. If any one of us three physicians, here, see this fever attack a native Cuban, we say, 'bilious remittent fever,' and if it attack a person not a native of Cuba, we say, 'yellow fever'; but at bottom, it is the same disease; and we agree to call it bilious remittent fever in Cubans, solely because these believe themselves exempt from yellow fever, and are so prejudiced that they would be alarmed if assured their disease was really yellow fever." Dr. Navea further reports that this fever equally prevails at Jaruco, about 12 miles northeast of San José, and where he practiced for fifteen years.

Dr. Mantignagi, of Cienfuegos, reported (vol. 2, 1876, p. 63, of the Havana "Cornica Med. Quir.") as follows: "During December, 1875, the sanitary condition improved, but a certain fever has prevailed among children, which is known here as typhus, although it resembles in nothing the disease to which Europeans give this name, and which so often occurs in camps. By this fever I have lost one patient, a child eight years of age, born in this town. It presented all the symptoms of yellow fever, for on the second day this patient had the characteristic vomit and stools, and died on the third day. In a consultation held with three other physicians, they agreed with me in my diagnosis, with this difference, that they said that these same symptoms which constituted yellow fever in strangers constituted in natives the typhus. I have been told that 8 to 10 children have died of this disease."

Dr. Ramon de Mazarredo, a native of Cienfuegos, a graduate of the Universities of Pennsylvania, of Paris, and of Havana, and one of the most experienced, reliable, and accomplished physicians of Cuba, presented to the commission a very valuable report, from which are taken the following extracts:

"Native-born Cubans coming from a healthy district to one where yellow fever prevails are as liable to this endemic as are unacclimated foreigners; while those that are born and remain a certain number of years in the infected region are exempt from it."

Graduating in Paris in 1860, Dr. Mazarredo was familiar with and inclined to concur in the view of the immunity of children and natives entertained by Bally, Hume, Faget, Cowley, and other distinguished physicians. Notwithstanding this, the results of twenty years' experience caused him to write in 1879 as follows: "In my own practice I have seen cases of yellow fever in children, from one to five years old, and even not over a year old, in whom it has been fatal, and I am now well convinced that children born in Cienfuegos are exactly in the same conditions the first years of their lives as are other new-comers, and are just as liable to its attacks. Nevertheless, I consider that children are generally less prone to suffer severely, owing to their different conditions of living, enjoying in this respect the same privileges as the better class of foreigners, who suffer little.

"It is to be remarked, also, that women suffer less than men, a result probably due to their greater seclusion. But in years when the disease is violent, as in 1868, 1870, 1876, the mortality is great in all classes, not even excepting children. In some of these the fever is mild, but in others so malignant that they have died from the fifth to the sixth day after ejecting the characteristic coffee-ground vomit. I have also attended native children from the interior, as well as lads freshly arrived from Spain, and not above ten years old, and I could not perceive any difference whatever in the symptoms, compared with those of yellow fever in the adult.

"Worthy practitioners of this locality give the name typhus fever to these cases, and although they admit that no difference whatever exists between the symptoms, march, and duration of this, compared with yellow fever, still they think the former a swamp fever, and hence more amenable to quinine, which it is generally admitted does positive harm in yellow fever. However, although very heavy doses of quinine are given from the outset, these fail to check or even favorably influence the termination of this so-called typhus. The less severe cases get well, but it is to be inferred

that these naturally tend to recover, and do recover in spite of the medicine." "I hope that I have made it clearly understood that I am thoroughly convinced that yellow fever attacks native-born children of, as well as all new-comers to, a locality where this disease reigns endemically; that all inhabitants of such localities have in their time had yellow fever once; and that, since this disease attacks but once in a lifetime, hence, for this sole reason, the acclimation or immunity thereby acquired is permanent and never lost."

The views above quoted are those of a small yet very intelligent minority of the physicians of Cuba, but the views of this minority are very much strengthened by the fact that they are upheld by the majority of distinguished physicians in other yellow fever centers than Cuba. In proof of this the following facts and quotations are presented:

Heinemann reports in 1879: "Until lately the physicians and people of Vera Cruz supported with fanaticism the dogma that natives were absolutely exempt from yellow fever. But the fearful epidemics of recent years (1875, 1877, 1878) have worked a change; for so many native children and adults suffered that the truth could no longer be denied that these do not enjoy an absolute immunity."

From Rio de Janerio it is reported that when yellow fever reappeared in 1849–1850, after more than a century's absence, the natives suffered severely, but not so severely as new-comers; and Dr. Rey, of the French navy, reporting the epidemic of 1876, says that the natives were attacked, refers to medical authorities who concur in this, and quotes the mortality statistics, which include some children under ten years among the deaths by yellow fever. The health inspector of the port of Rio de Janeiro reported that of 733 deaths by yellow fever during the first nine months of 1879, "twelve were *natives* of Rio." Dr. Gorgas, Surgeon U. S. Navy, has reported that while since 1873 unacclimated foreigners are most susceptable, yet that "all classes and all races are attacked." I have not been able to find any Brazilian authority contradicting such statements.

Turning to modern French literature there will be found complete unanimity on this subject. Dutroulau, Cornilliac, Féraud, Lota, De Lavison, Du Bellay and others, in fact all who are known to me, unite in teaching the liability of the creoles of the French Antilles and of Africa to yellow fever; that the immunity of both adults and children is relative and not absolute; and that this apparent immunity is well marked only among those creoles born and resident in towns habitually infected. The following may be cited as one of many examples. Cornilliac (1873, p. 242) says: At Martinique, in 1869, "the epidemic influence was very remarkable on white creole children from two to eight years old, that is, on those born since the last epidemic [1857]. They were attacked suddenly without prodromes, with a very depressing access of fever, subsultus tendinum, convulsions, redness of face, and above all by repeated vomiting. The access terminated in 24 or 36 hours, and the child began to convalesce."

Mélier and Féraud incline to believe, while Lota and De Lavison, of extensive experience in Martinique, strongly advocate, the same view maintained by Dr. Mazarredo, that all creoles, either in childhood or subsequently, suffer from yellow fever, and gain their immunity by this method alone.

Blair, the unsurpassed clinical student and historian of the epidemic of British Guiana, 1851–'54, states that the very first cases occurred among little children, and that the attacks of others were numerous and repeated. "Infancy was one of the most favoring causes of the action of the yellow-fever poison. The constitution of the new-born or young white creole was highly susceptible. He or she was truly in the category of new-comers." In 1851, yellow fever had been absent from British Guiana for six years, since 1845.

In 1851 the medical profession of New Orleans was almost unanimous in teaching that those born in that city were not liable to yellow fever. Prof. Warren Stone, my teacher, was then one of the very few who taught that creole children did have yellow fever, often in a form too mild to justify an absolute diagnosis. From 1853 to 1860 I was the associate of Dr. Armand Mercier, who was then, as now, an earnest advocate that the creoles of New Orleans were exempt from yellow fever. Thus, my attention has been directed for many years to this subject, and I have lived to find that Professor Stone's view has so triumphed that there are now in New Orleans no physicians known to me, having experience and distinction, except Drs. Mercier and Faget, who uphold the old view. That this change has been so complete I attribute chiefly to the fact that until 1858 New Orleans was ravaged by almost biennial epidemics, while since 1858 there have been only two serious invasions, in 1867 and in 1878. The longer the intervals between epidemics the larger necessarily must be the number of those who have failed to acquire immunity, and the more glaring becomes their liability to the disease. This is the explanation of the very old observation that the longer the absence of an epidemic from a place the greater the susceptibility of its inhabitants.

It is believed that the facts now presented tend very strongly to the conclusion,

although diagnostic deficiencies may render it impossible to prove it absolutely, that the creole children as well as adults of Cuba, as of other yellow-fever regions, are liable to yellow fever; and that the extent of their apparent immunity is proportionate to the extent of their exposure to the poison of the disease. Wherever yellow fever occurs only occasionally as an epidemic, there the creoles are manifestly liable to the disease; wherever it prevails habitually, there the creoles appear to enjoy a very great, if not absolute immunity; and the fact that the white natives of any place do enjoy this comparative immunity is good evidence that the poison of yellow fever prevails habitually in this place. Hence, the important practical conclusion that the stranger should beware, during the warm season, of every place in Cuba or elsewhere of which the natives boast that while the foreign-born habitually, they never suffer with yellow fever.

It has already been intimated that authorities are generally too absolute in their assertions as to liability to and immunity from yellow fever. Because some or many may be liable, or the reverse, is not proof, as is generally implied, that all of the same class are in the same condition. In respect to the degree of liability it is important to draw attention to some other facts, besides those already stated, in order the better to consider the causation of immunity from yellow fever.

In infected places, are all foreign-born whites, under apparently like conditions, equally liable to yellow fever? All authorities teach that in yellow fever as in other diseases there are some few persons of such peculiar constitution that they are not liable: that women, sucklings, and the aged enjoy a comparative immunity; that those who come from cold northern latitudes or from high altitudes are more liable than those who have inhabited warm southern plains; that the robust and plethoric are more liable than the feeble and anæmic; and that those engaged in occupations near the fire, bakers, blacksmiths, &c., are the most liable, while those occupied in pursuits which subject them to the inhalation of putrid air, scavengers, tanners, soap boilers, &c., are least liable. Notwithstanding this universal teaching, there is a great lack of reliable statistics and of scientific proof to establish what is thus taught; and there is much room to question whether the immunity, so generally admitted, is not in large degree apparent rather than real.

Few students of modern researches into the nature of zymotic poisons will refuse to credit that the poison of yellow fever is particulate rather than gaseous. If so, then the escape of a few persons, during even the most violent epidemic, would not necessarily prove that their exemption was due to some incomprehensible idiosyncracy any more than the survival of one Spartan out of the 300 at Thermopylæ proved that his peculiar idiosyncracy exempted him from the slaughtering swords and spears of the Persians. Some veterans, with no lack of susceptibility to lead particles or bullets, have escaped unharmed, not from one alone, but from a hundred murderous battles. Manifestly, more knowledge than science now possesses must be acquired on this subject before we should teach dogmatically. It is still more probable that the comparative immunity of women, of the aged, and perhaps of sucklings, is in some measure more apparent than real; due in the case of women largely to their more secluded lives, for repeated instances have occurred where theatrical companies have been exposed, and the female artists have suffered equally with the males; due, in the case of the aged, largely to the same cause, as well as to their very limited number in tropical countries and to a forgotten or misapprehended attack of this non-recurring disease having been experienced in earlier years; due in the case of sucklings, probably also in large measure to seclusion. As to the apparent immunity of sucklings, it is worthy of note that this has also been observed in typhoid, typhus, and scarlet fever, in cholera, influenza, and croup; and further, that it is possible that diet may play a part in the matter, for it seems certain that this cause is potent in at least splenic fever, to which herbivora are very liable, omnivora less, and carnivora least. In respect to the somewhat greater liability of the robust and plethoric, and of the inhabitants of cold countries, there seems to be less reason to doubt that this is real; it is the common belief and numerous statistical tables, all, however, too regardless of the difference in surrounding conditions to be conclusive, tend to confirm this belief. The greater liability of artisans working in hot places, and the comparative immunity of those exposed to foul emanations, has been accepted on very loose evidence. The only statistical research on the subject, known to me, is recorded by Dr. Rey, in reference to the Rio Janeiro epidemic of 1876. This research proves that cooks, bakers, blacksmiths are among those who, on the contrary, are least liable; while the persons very much the most liable are those who, like cabmen, policemen, and newspaper reporters, are engaged in ambulatory occupations. This result of statistical research is much more satisfactory than the accepted belief, for it is easily explicable, and in perfect accord with such facts as the comparative immunity of women and others leading sedentary and secluded lives. Seldom are all parts of a yellow-fever battlefield equally dangerous, and the chances of those forced to traverse daily all parts of it are much less favorable than are the chances of those confined to one small section of the field. Farther, it should not be forgotten that it has been repeatedly observed that those who sleep and live above the ground,

the higher the better, suffer less than those who sleep and live on the ground or ground floor.

These facts, in respect to foreign-born whites in infected places, tend to show that while some may enjoy comparative immunity from yellow fever, perhaps, especially those from warm lowlands, who, it should be remembered, are in considerable number malarious, feeble, and anemic, yet, that some of the alleged causes of immunity are apparent rather than real.

What degree of immunity is enjoyed by the colored races? Certainly a greater degree than by the whites. None the less, even the pure African negro is very far from enjoying an absolute immunity, and there are facts to prove that the causes of the comparative immunity of the colored races require the consideration of more than race differences.

Moufflet testifies that the red Indians of the warm lowlands of Yucatan are susceptible to yellow fever; numerous authorities unite in stating as the result of many years' observation that at Vera Cruz the pure-blooded Indians from the cold highlands of Mexico suffer from yellow fever even more than recently arrived Europeans; and Archibald Smith cites numerous medical witnesses in proof that, in 1853-'56, the Indians of the Peruvian Andes were destroyed in vast numbers, and to greater extent than the foreign-born whites. In face of such evidence, we are forced to suspect that the comparative immunity of the Indian, usually observed in other places than Vera Cruz and the Andes, was due to other causes than the mere fact that he was an Indian. May it not be that the Indians who do enjoy comparative immunity are those only who, living in malarious lowlands, are feeble and anemic; while the hardy mountaineer is very susceptible? The great susceptibility, under certain circumstances, of the Indian of the present day, has served to confirm the conviction I have long entertained that yellow fever did not originate with the settlement of San Domingo by Columbus. Because unknown to Europeans, because undetected, among acclimated Indians, by ignorant adventurers, with no thought, except for conquest and for gold-mines, is no proof that the disease did not exist, and had not existed from time immemorial. It has been proved, solely because of records such as Indians had not, that small-pox was known in China at least eighteen hundred years before its first appearance in the eighth century in Europe; who would now contend that small-pox must have *originated* at some definite date in either Europe or China?

In Cuba many physicians assert that the Chinese never suffer with yellow fever. This was found to be a great error, for a few days of investigation gathered authentic reports of more than a dozen cases. One of these reports was from the officers of the Garcini Infirmary, and to the effect that of about 90 Chinese specially noted, there had been 10 attacked and 3 deaths. As the importation ceased in 1874, every succeeding year has naturally rendered Cuban experience less valuable. But, apart from Cuban experience, the Chinese in others of the Antilles and in the United States have proved beyond question their liability to yellow fever, and at the same time their comparative immunity.

The same has been proved by the English and French, in Guyana and the West Indies, in respect to coolies from Hindostan and other parts of Southern Asia. In regard to the comparative immunity of the Asiatic races, it should not be forgotten that the vast majority of these come from tropical malarious lowlands. This becomes all the more worth noting when associated with the reported fact that Hindoos from the lowlands show far less susceptibility to cholera than Europeans, but that natives from the Hymalaya Mountains are just as susceptible as Europeans.

Similar facts as to negroes are recorded. In Cuba many physicians assert that negroes enjoy an absolute immunity, but even if this were true, as it is not, in respect to all Cuban negroes, it would not be thereby proved that they owed their immunity to the sole fact that they were negroes. There are numerous records like the following: "In the terrible irruption of 1802 the African negroes, acting as nurses in the hospital of Fort de France, Martinique, were attacked, and all died, except some old men!" But the most remarkable well-authenticated instance of this nature is in reference to the visitation, after many years' absence, by the violent epidemic of 1830, of the little French island of Gorée, some 90 miles from the West African coast. This epidemic not only attacked 144 out of 150 total European population, but is reported to have been equally destructive to the native Africans. Gorée is an arid volcanic rock, destitute of marshes, and very healthy; and therefore its native inhabitants were free from swamp poison, and probably hardy and robust. Is not the suspicion justifiable that the unusual susceptibility of the negro on this occasion was due to these causes? It is not strange that this unusual susceptibility was not observed during succeeding epidemics, inasmuch as so large a number had suffered the one necessary protective attack during the first epidemic. But the comparative immunity of the negro, under apparently the same circumstances as the white man, has been proved repeatedly in the United States, and never more conclusively than in 1878. However, the statistics of United States white and colored soldiers at New Orleans during the violent epidemic of 1867 present probably the most trustworthy data in respect to the

relative liability of whites and negroes. For every 1,000 white soldiers there were 866 cases of yellow fever, and 256 deaths, or one death to every 3.9 soldiers, and to every 3.38 cases. While for every 1,000 colored soldiers, there were 521 cases, and 73 deaths, or 1 death to every 13.7 soldiers, and to every 7 cases. Now, while it is true that the chances are great, that there were more colored soldiers from southern malarial, yellow-fever latitudes than white soldiers, yet this difference was probably insufficient to account for the above difference in susceptibility. These facts seem to prove that while the immunity of the negro has been much overrated, and this immunity attributed to race peculiarities without sufficient consideration of other conditions, yet that his comparative immunity from yellow fever is a reality, as also is his less susceptibility to malarial fevers.

In searching to discover how immunity from yellow fever may be acquired, it is necessary to bear in mind the facts now stated in order to avoid hasty and exclusive conclusions.

MODES BY WHICH IMMUNITY FROM YELLOW FEVER MAY BE ACQUIRED.

Consideration of this subject requires that all conceivable modes, whether possible, probable, or certain, should be kept in mind. They may be summarized, and will be considered in the following order:

I. Acclimatization, *i. e.*, gradual habituation and accommodation to the climatic conditions of non-infected localities, adjacent to infected localities.

II. Increased physiological power of excretion.

III. Inheritance.

IV. Habituation to other poisons than yellow fever, and the production thereby of bodily conditions less favorable to this poison.

V. Habituation in infected localities to the poison of yellow fever.

VI. One attack of this non-recurring disease.

I.—ACCLIMATIZATION.

English and French physicians, military and civil, are now in perfect accord on this subject. This accord is due to many years of experiments in yellow-fever regions, by which many thousands of lives and many millions of money have been sacrificed. As a result of these experiments, hospitals or camps of acclimation have been abandoned everywhere, as well as in Cuba*, and have been replaced by encampments, in adjacent non-infected localities, solely for protection; the European soldiers' term of service has been shortened; and European troops have been replaced, as far as practicable, by creoles and negroes. The testimony of some few of the most distinguished physicians in military service deserves record.

Recounting the various insanitary evils to which the British soldier in the West Indies was formerly subjected, Parkes says (p. 636, 5th Ed. Parkes Hygiene): "To us, these numerous causes seem sufficient to account for everything, but in former days an easier explanation was given. It was held to be the climate; and the climate, as in other parts of the world besides the West Indies, became the convenient excuse for pleasurable follies and agreeable vices. In order to do away with the effects of this dreadful climate, some mysterious power of acclimatization was invoked. The European system required time to get accustomed, it was thought, to these climatic influences, and in order to quicken the process various measures were proposed. At one time it was the custom to bleed men on the voyage, so that their European blood might be removed, and the fresh blood which was made might be of the kind most germane to the West Indies. At other times an attack of fever (often brought on by reckless drinking and exposure) was considered the grand preservative, and the seasoning fever was looked for with anxiety. The first statistical report of the army swept away all these fancies, and showed conclusively that instead of prolonged residence producing acclimatization and lessening disease, disease and mortality increased regularly with every year of residence."

Aitken teaches: "There can be no acclimation to causes of disease, and climate *per se* has been made to play the part of scage-goat for the neglect of sanitary precautions."

Dutroulau writes (pp. 430–1: "No acclimation is acquired except to those who have passed through a preceding epidemic period, * * * and above all by those who have had an attack of complete yellow fever." "When the epidemic broke out in Martinique, in 1851, the whole garrison had been in the colonies from four to five years, * * * yet they furnished as many sick and dead as the sailors who had arrived only a few months or days before."

*The following have been acclimating stations for the soldiers of Spain, in Cuba: Guanabacoa, Güines, Isle of Pines, Jaruco, Mariel, Pinar del Rio, San Antonio, Santa Clara, and Santiago de las Vegas. Dr. Antonio Pardiñas, medical director military hospitals in Havana, wrote, August 19, 1879, "in regard to the different places of acclimation, they have given unsatisfactory results, as the military hospital statistics will show."

Cornilliac (1873) testifies: "Acclimation it secured only by residence in infected places during epidemics" (p. 104). "Only those Indians and white creoles enjoy immunity who live where yellow fever generally prevails" (p. 213), and "there is no acclimation against yellow fever. There is nothing except a first attack during an epidemic which can preserve one."

Du Bellay wrote in 1870, that acclimation is illusory, for he has seen many soldiers suffer with yellow fever who had been at Guadeloupe more than five years.

Féraud, writing in 1874 his experience of yellow fever in Africa, says: "At Senegal prolonged sojourn has no such happy acclimating effects as reported in the Antilles." Subsequently he served in the Antilles, and recording in 1878 his experience in Martinique, he found that the "happy acclimating effects" which had been reported were not real, and concurs fully with the views of Dutroulau, Cornilliac, &c.

The experience of the most eminent medical civilians is to the same effect in all yellow fever regions.

Heinemann states, while Vera Cruz acclimatizes its inhabitants, yet those living but a short distance, north, south, or west, gain no immunity from yellow fever.

Dr. Armona, writing for Drs. Forns, Beltran, Morado, and himself, physicians of Marianao, Cuba, states: "We all entertain little confidence in the immunity from yellow fever acquirable by long residence in this place (some six miles only from Havana); this lack of confidence is not simply limited to this locality, but extends generally to all places in Cuba where yellow fever does not occur. Instances are known to prove this; among these are the cases of two English mechanics, who after more than eight years' residence on the adjacent Santa Rosa estate of Mr. Aldama, proceeded to Havana, to take passage home, and died in Havana of yellow fever. During said years they had visited Havana, or other infected place, very seldom and briefly."

Innumerable instances could be recorded of men residing fifteen years and more in non-infected tropical localities, and though yellow fever had invaded adjacent places north, east, south, and west of them, still the very same climate had effected so little that they died of yellow fever on being subjected to an infected locality.

There can be no doubt, then, that immunity from yellow fever cannot be gained through the influence of climate, and therefore, that it is an abuse of language, due to past ignorance and misconception, to continue to designate the acquisition of immunity from yellow fever, "acclimation," or "acclimatization." These deceiving words, and all of their derivatives, continue to be the foundation of many errors and misconceptions, but, unfortunately, they have gained such foothold that, in the absence of any one word to express the correct idea, it is very inconvenient to abolish them. In upholding this view, there is no intention to deny that, possibly, those may be less liable to yellow fever who have lost healthy plethora and vigor, and have become weak and anemic through the influence of long continued heat, or through the influence of any such cause as malarial poison which though a climatic coincident is not a climatic factor.

Are there any facts known in reference to the acclimatization of vegetables and of the lower animals which would justify the belief that immunity from yellow fever can be gained through the influence of climate? I have failed to find any such facts. There are many remarkable examples, illustrating the power of vegetables and animals to gradually accommodate their existence to different degrees of temperature, humidity, altitude, and of other climatic factors; but there is no reason to believe that this gradual adaptation of physiological functions to widely different climates is associated with altered susceptibility to the action of poisons. This erroneous belief is due to confounding two very different things; for, the accommodation of physiological functions to the climate of a place, and habituation to some poison which happens to be in the same place, are two very different things, which science should cease to confuse by giving to both the same designation, acclimatization. Only to the former process can this term be properly applied, and there are, in reference to it, some facts taught by botany and zoology important in the present connection.

Darwin teaches that acclimation is effected "by spontaneous variation, aided by habit, and regulated by natural selection." "Habit, however much prolonged, rarely produces any effect on a plant propagated by buds; it apparently acts only through successive seminal generations." "With plants propagated by seed, and with animals, there will be little or no acclimatization unless the hardier individuals are either intentionally or unconsciously preserved." De Quatrefages also teaches that the acclimatization of plants and animals is acquired by hereditary descent; not years, but generations are required.

Each set of facts now presented unite to justify the conclusion that immunity from the yellow fever or other poison cannot be acquired by acclimatization, that any influence exercised by climate is secondary and slight, and that even this slight indirect influence is, as yet, unproved, therefore uncertain.

II.—INCREASED POWER OF EXCRETION.

The view has been advocated that the varying excretory powers of individuals might serve to explain, at least, in part, their varying susceptibility to the poison of yellow fever; and that the comparative immunity of some persons, of tropical creoles, of negroes, &c., might be due to the greater activity of their excretory functions.

There are only four great excretory organs, the lungs, kidneys, bowels, and skin. As is well known, the functions of the three former are diminished by heat, and therefore reduced in summer, and in the tropics. Hence the discussion is reduced to increased excretion by the skin, which, there is reason to suspect, may be the organ by which the poison of yellow fever is chiefly eliminated. The odor, the profuse sweating, the petechiae, the boils of yellow fever, give countenance to this suspicion. But, science is destitute of facts tending to prove that the skins of acclimated residents are more active than the skins of unacclimated new-comers. Contrasting northerners with southerners the reverse is probably true, since an unusual stimulant excites an organ's function more than an habitual stimulant. We have still less reason to credit any difference between the cutaneous functions of those who reside in a non-infected locality, within a few miles even of an infected locality, and of those who reside in the latter, yet the liability of the former is very much greater. Farther, it is impossible to admit that every native child can take a dose of yellow-fever poison fatal to many foreign-born adults, and, because of superior excretory power, experience, as is alleged, no ill effects whatever. Healthy activity of the excretory organs is certainly desirable whenever there is exposure to a poison, but the various facts presented, in regard to immunity from the poison of yellow fever, cannot be explained by the theory that the susceptibility is due to varying excretory power.

III.—INHERITANCE.

It may be naturally presumed, that parents who have acquired exemption from a non-recurring disease would be more apt to beget children insusceptible to said disease. However, although there are a number of these diseases, no evidence has been presented favoring this supposition. The subject deserves research. Several generations, if not the first, might show lessened susceptibility. The little reliable evidence I have gathered on this subject, as it respects yellow fever, is entirely unfavorable.

Dr. Burgess reported the death, by undoubted yellow fever in 1879, in Havana, of a child three to four years old, born in Europe of acclimated Cuban creoles. My colleague, Professor Logan, reported to the Orleans Parish Medical Society the following facts: His ancestors had resided in Charleston, S. C., since the seventeenth century, and were presumably acclimated. His father and mother certainly were. They had eleven children, of whom nine at least had suffered with yellow fever. His brother, one of these nine, married a creole, a member of an old acclimated family of New Orleans, who bore him two children between the great epidemics of 1858 and 1867; both of these were attacked in 1867; four others were born between 1867 and the next great epidemic in 1878, during which all four were attacked, two violently and one had black vomit.

This evidence tends to prove that which no one has denied, that parents who have had yellow fever do not because of this beget children insusceptible to the disease; and there is no reason to believe that foreign-born parents who have had yellow fever can because of this beget children, in habitually infected places, who in the very first generation are insusceptible to this disease; yet, even such children are alleged to enjoy as complete immunity as all others. Hence, it is certain that the wholesale immunity which is alleged to be enjoyed by all children born in habitually infected localities cannot be due to inheritance.

However, it is probable that a fetus in the womb during the time when the mother recovered from an attack of yellow fever may have suffered with her, and thereby have become insusceptible to a second attack. Farther, it must be admitted that it is not known that the law of "the survival of the fittest" may not be applicable to yellow fever, possibly to the extent that parents, among those exceptional few who were never, or perhaps very little susceptible, might beget descendants who would be insusceptible.*

IV.—HABITUATION TO OTHER POISONS THAN THAT OF YELLOW FEVER.

Recent researches on the antagonism of medicines encourage the suspicion that there may be antagonistic disease poisons, and that habituation to one might destroy or

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* Sir Henry Holland taught in 1851 (see note on p. 82 of "Medical Notes and Reflections"), that evidence warrants the opinion "that repetition of a given disorder through successive generations may alter the liability to receive it under its most severe forms." And, Dr. Lyman asserts (N. Y. Medical Record, September 4, 1880), that an "hereditary tolerance" to such diseases as small-pox, measles, and scarlet fever does grow up in communities subjected to these diseases. However, neither he nor any one else has ever yet presented anything like adequate evidence in proof of any such "hereditary tolerance."

diminish the susceptibility to another. To what extent is this view justified by facts so far as yellow fever is concerned?

It has been taught that those engaged in occupations which exposed them to putrid emanations were less liable to yellow fever. This teaching is founded on that kind of ipse-dixit evidence which is valueless in science, and is frequently associated in some other part of the same book with the discordant lesson that yellow fever is caused by and has a spontaneous origin in putrid emanations.

It has also been taught that those exposed to malaria were less liable to yellow fever. It is, however, well known that persons saturated with malaria, and even while suffering violently therewith, are not infrequently attacked by yellow fever. All the facts we have tend to prove that there is no antagonism between the poison of yellow fever and the poisons of malaria, cholera, and small-pox. Each of these three diseases have been repeatedly seen coexisting with yellow fever in the same person; and, it is worth noting that in such cases, while yellow fever predominates over swamp fever, small-pox and cholera are reported always to predominate over yellow fever. Notwithstanding all this, there is some reason to suspect that the anemic and feeble may be less liable to yellow fever than the robust and plethoric; and, as is well known, anemia, the sequence in large measure of malaria, is the prevailing pathological characteristic of the inhabitants of tropical malarious lowlands. An intelligent American from the swamps of Illinois, long resident in Havana, was very positive that his countrymen from malarial districts had suffered less with yellow fever than those from non-malarious localities. But since even these do suffer often severely and in large number, it is impossible to admit more than that these causes may exercise a slightly favorable influence, while totally insufficient to explain the wholesale immunity, apparently enjoyed, by the natives of habitually infected localities.*

V.—HABITUATION IN INFECTED LOCALITIES TO THE POISON OF YELLOW FEVER.

Since the facts thus far presented are inadequate to account for the apparent immunity from yellow fever enjoyed by vast numbers, if not by all of the children and natives of such places as Havana and Vera Cruz, the cause of this wholesale immunity must be due either to the gradual habituation to the poison of yellow fever, or to the well-known influence of a first attack.

Thus far science fails to teach that there is any disease-poison possessing the wonderful power claimed for the poison of yellow fever, viz, that children subjected to its influence become insusceptible to, without suffering from it. The only approximative instance is furnished by the much milder protective, but very manifest disease, which results from inoculation of the small-pox virus, and from vaccination.

As to other poisons, none of which, says Taylor, are inorganic, such as alcohol, tobacco, and opium, it is well known that while some few persons show on the one hand excessive susceptibility to small, and on the other hand excessive tolerance (independent of habit) for large doses—both of which may be lost—all persons have the power to habituate themselves to toxic doses. But how is this power gained and at what expense? It is gained through small, always nonfatal doses, long continued; and it is gained at the expense of health. Taylor concurs with other toxicologists in teaching that "as a general principle we must admit that habit cannot altogether counteract the insidious effects of poisons; and that the practice of taking them is liable to give rise to disease or to impair health." Now, if children gain immunity from yellow fever by habituation to its poison, then the extraordinary and solitary example is presented of one poison which can with impunity and without any subsequent impairment of health be administered to little children in doses fatal to unacclimated adults. This seems incredible.

But, statistical records unite with general experience in proving that at least sucklings suffer comparatively little from the poison of yellow fever, as also of several other zymotic diseases. Granting this due to a real, and not to a merely apparent, insusceptibility; then, even in such case, can the supposition be justified that these insusceptible children may be so dosed with the poison, that habituation to it, without causing any disturbance, protects them forever afterwards; not only on arrival at the susceptible age, but also on return to an infected locality after many years cessation of the use of the poison, the result of prolonged residence in some distant non-infected locality? Excluding yellow fever, no such wonderful results have ever been claimed for any other poison whatever. No medicinal poison, no disease-poison acts in this wise, as far as now known to science. This view is not only repugnant to the knowledge possessed of all other poisons, but it is repugnant to the teachings of physiology. The healthy body manifests a constant tendency to return, after subjection to abnormal conditions, to its usual normal state. Even the reformed opium eater, habituated to enormous doses, cannot, after their long discontinuance, venture to resume the poisonous dose once comparatively harmless.

* The physiologist must hesitate to admit that ill health, however produced, can serve as a protection from any disease. It is regretted that time and opportunity have been lacking to enable me to collect all the alleged facts respecting the protection from certain special diseases given by certain diseased conditions of the body. Such a research might have thrown some light on the present subject.

There are many indisputable instances of persons residing in annually infected localities for more than five years, some for even more than thirty years, and dying with yellow fever, even after such prolonged exposure. These cases, whatever else they may prove, certainly fail to prove that immunity is easily to be procured by habituation to the poison.

In the face of these weighty objections, there are many physicians, always most numerous and positive where yellow fever most prevails, who would have us waive these aside, rather than believe that they are in error in respect to that difficult matter, the diagnosis, especially of the milder attacks, of yellow fever. A matter so difficult, that some, even of the most serious cases, notoriously give rise, during every invasion of the disease, to differences of opinion between physicians of the greatest experience and attainments. It is certainly far easier to credit fallibility in diagnosis and observation, than to credit that the poison of yellow fever has a mode of action entirely unlike the action of every other known poison; for man's proneness to err is as remarkable as is the uniformity of nature's action.

VI.—IMMUNITY GAINED BY ONE ATTACK.

The only known mode of acquiring immunity from every other non-recurring disease is to have one attack; and, so far as yellow fever is concerned, while various modes are claimed, this remains the only one so certain that no one whatever disputes it.

Mindful of the varying susceptibility of races, as also of individuals and classes of the same race, no one will be disposed to deny that there are causes, such as have been referred to, and other than an attack of the disease, which tend to so affect the constituents of man's body that its susceptibility to the poison is diminished. None the less, facts will now be presented in proof that immunity from yellow fever is acquired by a large majority of the natives of infected places in the same manner it is acquired by unacclimated immigrants, and in the very same manner that immunity from every other non-recurring disease is acquired. Nature often contradicts herself in appearance, but never in reality. Although I, in 1870, solicited professional attention to this same class of facts, yet they are now presented, for the first time, in a form so extensive and decisive that their all important significance cannot be doubted. Fortunately these facts are so patent that they appeal to the common sense, even of the unprofessional; and they are independent of diagnostic subtleties, such as, whether every case of yellow fever must be characterized by a special pulse and heat curve, or by some albuminuria, or by so much blood and so little bile in the vomit, or by a special hue, or by a diagnostic facies, *et id omne genus*.

These facts will be found in the appended statistical tables Nos. 13, 14; table No. 13 consists exclusively of official data of population from the United States census, and of deaths from the board of health in New Orleans; table No. 14 consists of results obtained by calculations based on the original data in table No. 13—calculations designed to facilitate the interpretation of these original data. These tables present the facts pertinent to our subject, as they have occurred in New Orleans since 1856; that is as far back as authentic records can now be procured. This period includes three of the most disastrous epidemics—1858, 1867, 1878—which have ever desolated New Orleans, and the tables present the results of these epidemics in contrast with the non-epidemic years which immediately preceded and succeeded each of the three epidemic years. It will aid a thorough interpretation of the facts to state that New Orleans suffered disastrous epidemics during the three consecutive years of 1853, '54, '55; that in 1870 there were 587 deaths by yellow fever, and 226 in 1873; that these years teach, less strikingly, of course, the very same lessons taught by the violently epidemic years; and that, until 1858, the great majority of the medical profession of New Orleans taught with as much vehemence as some few of them still do, and as nearly all the physicians of Havana and Cuba now teach, that the native born creole children and adults enjoyed absolute immunity from yellow fever. Hence it is not doubted that similiar statistics for Havana and all cities infected by yellow fever, will, if ever obtained, teach the same lessons taught by the statistics of New Orleans now presented. What are the lessons thus taught?

First. Comparing every epidemic year with the non-epidemic year which both preceded and succeeded it, there will be found invariably an enormous excess during every epidemic year, in the deaths of children under ten years of age. It will further be found that this notable excess in the annual deaths invariably occurred during the very months when yellow fever devastated the city. What killed these children? If yellow fever did not destroy them, then there must be some one or more disease-poisons, which are invariably associated with the yellow fever poison, and which have the astounding peculiarity that, at the very time when the latter is destroying the adults, the former is slaughtering the children. There is no escape from the conclusion that either the children of New Orleans are very susceptible to yellow fever, or that some other children's disease-poison always accompanies the poison of yellow fever—an alternative opposed to a prevalent opinion that, during epidemics, the accli-

mated generally enjoy better health. Those who deny the former, deserve no consideration until they have explained the latter alternative. In illustration of other epidemic years, consider the significance of the following indisputable facts from the cemeteries of New Orleans, as to our last great epidemic. Of children under ten years of age, the average number of deaths for the two non-epidemic years, 1877, 1879, was 2,024, but in 1878 the number was 3,930, or nearly double, being 1,906 more than the average of the non-epidemic years. Searching for the period of the year when this excess occurred, it will be found that more than 1,906, even 2,023, died during the three epidemic months, than did die during these same months in 1877 and 1879. Once more, what killed this excess of 2,023 children? Let it be noted that the statistics state that 1,482 of them, and only 1,482, died of yellow fever; and among other things, indicate decisively the comparative insusceptibility of colored children.

Second. The tables prove that invariably during every epidemic year, and during the very months of said year when the epidemic prevailed, there was always an enormous increase in the certified deaths by certain fevers, especially by "bilious," "congestive," "pernicious," "malignant" fever (four types of malarial fever), and by "typhoid" and "typhus" fever. In this matter, let it be observed that the statistics turn aside from the simple and reliable tally of the sexton, and become dependent on the diagnostic skill and theories of the doctor. Were he as reliable as the sexton, no alternative would be left to the belief that the poisons of swamp, of typhoid, and of typhus fever invariably accompany the poison of yellow fever, always increasing and decreasing *pari passu* with this. The doctors of Havana and of Matanzas—and probably everywhere else in Cuba—unite, as shown by their mortality statistics, in teaching this very same lesson taught by the doctors of New Orleans. Since these doctors have been so unconscious of their own curious teaching that they have even failed to call attention to it, and since it imposes a great strain on professional credulity, science must incredulously await proofs much stronger than those dependent on disputable diagnoses, before crediting that either malarial, typhoid, typhus, or any other disease-poison invariably accompanies yellow fever, always increasing and decreasing with it.

Third. This same class of facts, derived from a comparison between the *certified* deaths by yellow fever, and by all other fevers which can be mistaken for it and for convenience are designated "malarial fevers," teaches another important lesson. The many physicians now in New Orleans, who no longer credit the alleged immunity of creole children from yellow fever, have long contended that most of the deaths by the so-called malarial fevers during epidemics of yellow fever were really due to this disease; but, even if this probable supposition be accepted as the truth, and all these deaths be added to those of yellow fever, this sum fails to equal the excess of deaths which invariably occurs during epidemic years. Hence, if this excess be due to yellow fever, there must still be other diseases with which yellow fever is repeatedly confounded; probably such diseases as are certified to have caused death by "convulsions," "cerebral congestion," "teething," &c. This strong probability still further confirms the unreliability of the diagnoses of yellow fever.

Fourth. Accepting the conclusion that the excess of deaths which did occur during the prevalence of every epidemic was due to yellow fever, then it is in our power to estimate the comparative susceptibility at different ages. This has been done in Table No. 14, and for the first time, so far as known to me, in the literature of yellow fever, trustworthy data are presented of the ratio of deaths at different ages to the population corresponding to those ages. Examining the last two columns of Table No. 14, which columns compare the last epidemic of 1878 with the non-epidemic years 1877 and 1879, and illustrate like facts concerning the epidemics of 1858 and 1867, it will be found that there was an increased mortality in children under one year, but that this increase was comparatively slight; that this increase was much greater in children from one to two years old; that this increase was enormous in children from two to five years old, so that there were 95.9 deaths in every 1,000 of these in 1878, in place of 21.1 deaths in every 1,000 in the non-epidemic years, 1877 and 1879; and that this more than quadruple increase is not equaled at any other ages. While facts of this class as to other epidemics are similar, they are by no means identical. To comprehend these variations, it is indispensable to bear in mind the variations in the circumstances of the population, otherwise the student will be led astray. Take the epidemic of 1858 as an illustration. When it is known that the population of New Orleans had been subjected, so shortly before, to the three violent epidemics of 1853, '54, '55, and that, during this prosperous period of the city's history, unacclimated immigrants, chiefly from fifteen to forty years old, flocked to it in numbers far greater than subsequently, no one will be surprised to find that the mortality in 1858, compared with 1878, was less in those under fifteen years, and greater in those from fifteen to forty years of age.

Fifth. Accepting the conclusion, drawn from the cemeteries, that the excess of deaths during an epidemic are due to the disease causing the epidemic, and again, taking the 1878 epidemic as an illustration, we are forced to admit that somewhere

between 1,406 and 2,023 children under ten years of age must have been killed by yellow fever; and, therefore, that a very much larger number recovered from the disease, thereby gaining that absolute immunity which it is claimed is the birth-right of creole children independent of any such process. What number of the creole children of New Orleans gained their immunity from yellow fever in 1878, becoming "acclimated" by an attack of yellow fever? Of course this question can only be answered by vague approximations for failure to report cases and diagnostic difficulties deprive us of the most important factors in the problem. None the less, there are some facts which throw a little light on the difficulty. In 1878, the children under ten years of age numbered about 50,000; of these, probably more than 10,000 fled from the city; more than 10,000 were under two years of age, at which age so few died that we are justified in presuming them to be little susceptible to the disease, or at least to fatal attacks, and some had, no doubt, gained immunity from 1867 to 1878, especially in 1870 and 1873, by an attack of yellow fever. Probably then, there were in New Orleans in 1878 less than 30,000 susceptible children exposed. If 2,000 of these died, then there could not have been less than 6,000 who recovered, even if we suppose children liable to as violent and as readily diagnosed attacks of yellow fever as are adults. But no one claims this; on the contrary, all who believe that creole children do not enjoy immunity from yellow fever, contend that these, especially the youngest, are, like the negro, less susceptible, and therefore liable to protective attacks which are often too mild to justify an absolute diagnosis. In this view of the case, it would be reasonable to increase many times the previously assumed 6,000, in order to fairly represent the probable number of the children in New Orleans, who gained immunity from yellow fever in 1878 by undergoing an attack of the disease.

Finally, mild, benign, aborted or bastard yellow fever deserves a brief consideration in this connection. That there is such a type of the disease is as certain as are discrete variola, varioloid, scarlatinous sore throat, choleraic diarrhœa, extremely mild typhoid fever, &c., so certain that wherever yellow fever prevails, there always have been and are still physicians of noted skill testifying to the prevalence of this form of the disease. In 1878, Féraud wrote the ablest and the only extensive treatise yet written on this form, as it exists in Martinique. He concludes, with hesitation, to adopt the term more commonly employed to designate it among French creoles; but, while thus designating it "bilious inflammatory fever," he assures us that it is the very same disease known by not less than twenty-one other names; among these are those I have used above, and also "acclimating fever," which he wisely suggests ought rather to be called the "fever of immunity." With Dutroulau, Cornilliac, Blair, and hundreds of others, he teaches that this disease is due to the poison of yellow fever, that creole children are very liable to it, as are also unacclimated immigrants, that its multiplicity of names indicates the difficulty of diagnosing it, and that its attacks frequently fail to confer immunity. Since it is so difficult to diagnose, the suspicion is justifiable that failures to confer immunity are proofs of diagnostic errors. But, discarding this suspicion, science teaches nothing which is repugnant to the view held by Dutroulau, Blair, and others, that only an attack of "complete" yellow fever, which has run through "its two stages" can confer an immunity so absolute that it can be relied on always, and by all. Incomplete attacks may or may not protect, just as one vaccination suffices for some, but fails for others. This view gains strength from two other considerations. First, from the recently reported experiments of Pasteur, which demonstrate that chicken-cholera germs find in different chickens a very variable amount of the pabulum on which these germs feed and multiply, thus producing the disease; and that weak inoculations, varying in different chickens, from one to four, and causing attacks varying in intensity are required to confer immunity from the disease. Second, young children being less susceptible to the poison should be less sickened by it; and while, on the one hand, this milder attack may be less destructive of the pabulum which the poison feeds on; on the other hand, their growing condition would be more apt to reproduce this pabulum, and thus renew their susceptibility. Without this old hypothesis, which Pasteur experimentally justifies by having proved its truth in chicken-cholera, it seems impossible to explain many cases like the following: The young brother of Dr. Montané, of Havana, passed all of his childhood in that constantly infected city, then, after residing nine years in France, returned to Havana and died with yellow fever, so well marked that, if I am correctly informed, no one questioned the cause of his death. Dr. Heinemann, of the constantly infected city of Vera Cruz, reports the death in that city, by well marked yellow fever, of an aged physician, a native of Vera Cruz, and long in charge of its military hospital, on his return to his old home after a few years residence in the city of Mexico.

While such cases may be thus explained, their great comparative rarity furnishes additional reason for the conviction that the vast majority of creole children do undergo attacks due to the poison of yellow fever; attacks which, however mild, suffice to protect fully as frequently as vaccination, limited to a single period of infancy, protects from small-pox. This view, long maintained by many physicians in New Orleans,

is in full accord with Féraud's, and apparently with the view of all the more recent French medical authorities at Martinique. But of far more weight are the facts that this view is in accord with the mortality statistics; with experience in all other non-recurring diseases; and, with the general observation in all yellow fever places, that when epidemics prevail obscure, ill-defined fevers, which different doctors baptize with a multiplicity of different names, accompany these epidemics. It is not doubted that a careful and prolonged study with the record of all such cases, especially as they occur in children, and influence immunity in after life, would ultimately convince all the distinguished physicians of Cuba that very many of these cases, however mild they may be, are due to the poison of yellow fever, and are in very numerous, if not in all, cases, "fevers of immunity."

In the mean time, it is believed that no one who rejects this view will find it possible to explain the significance of the indisputable facts recorded in the following Tables Nos. 13, 14, and to answer what disease is it, if not yellow fever, which invariably increases the mortality of children during the very time when yellow fever is increasing the mortality of adults.

Finally, the thorough study of the class of cases indicated would greatly tend to lessen the uncertainties which now obscure the diagnosis of yellow fever.

TABLE No. 13.—*Giving the population and the deaths in New Orleans by ages.*

[The deaths are given not only for the yellow-fever-epidemic years, 1858, 1867, 1878, and for the months of greatest prevalence, but also for the non-epidemic year immediately preceding and succeeding each of said three epidemic years—thereby proving an invariably great excess of deaths during every epidemic of (1) persons under ten years as well as of other ages, and (2) of so-called malarial and other fevers. The deaths by age and race of those dying with yellow and with malarial fevers are given for 1878 and 1879 only, since these data were furnished for the first time by the annual reports of said years.]

	1857.			1858.		1859.		Population by United States census of 1870.	1866.	
	Population by United States census of 1860.	Total annual deaths.	Deaths for the three months August, September, October.	Total annual deaths.	Deaths for the three months August, September, October.	Total annual deaths.	Deaths for the three months August, September, October.		Total annual deaths.	Deaths for the two months September, October.
*Still-born	....	358	91	338	110	353	94	....	412	79
Under 1 year	3, 637	1, 568	415	1, 944	632	1, 609	404	5, 135	1, 524	275
1– 2 years	18, 874	468	107	603	239	538	128	4, 183	518	71
2– 5 years		475	89	1, 001	616	505	104	15, 387	510	119
5–10 years	19, 038	205	34	365	178	326	81	21, 114	360	82
10–15 years	15, 365	117	21	293	178	153	31	21, 000	172	51
15–20 years	15, 595	130	41	579	418	231	71	19, 583	244	77
0–10 years	41, 549	2, 716	645	3, 913	1, 665	2, 978	717	45, 819	2, 912	538
10–20 years	30, 960	247	62	872	596	384	102	40, 583	416	128
20–30 years	36, 100	715	216	3, 025	2, 263	994	290	34, 340	1, 069	336
30–40 years	30, 963	768	195	2, 001	1, 283	1, 025	283	28, 804	991	304
40–50 years	18, 185	523	144	1, 040	500	762	182	21, 967	737	192
50–60 years	6, 770	297	77	463	201	331	95	12, 267	520	135
60–70 years	2, 890	155	38	216	101	196	52	5, 374	333	81
70–80 years	810	97	23	118	43	95	26	1, 711	147	27
80–90 years	255	38	4	45	10	51	13	398	51	10
Over 90 years	113	24	5	17	8	31	10	155	29	3
Not stated	80	....	......	....	....	....	......	....	549	145
Total population:										
White	144, 601	....	......	....	....	....	......	140, 923	......	......
Colored	24, 074	....	......	....	....	....	......	50, 495	......	......
	168, 675							191, 418		
Total deaths by all diseases	....	5, 581	1, 410	11, 710	6, 670	6, 847	1, 780	....	7, 754	1, 899
Deaths by yellow fever	....	199	107	4, 855	4, 481	91	60	....	192	149
†Deaths by other fevers, especially malarial	....	267	99	686	396	543	249	....	676	240

TABLE No. 13.—*Giving the population and the deaths in New Orleans by ages.*—Continued.

	1867.		1868.		Population by the United States census of 1880.	1877.		1878.	
	Total annual deaths.	Deaths for the two months September, October.	Total annual deaths.	Deaths for the two months September, October.		Total annual deaths.	Deaths for the three months August, September, October.	Total annual deaths.	Deaths for the three months August, September, October.
* Still-born	510	120	505	86	....	451	101	399	103
Under 1 year	1,863	461	1,608	241	5,041	1,228	260	1,259	402
1- 2 years }	529	175	364	59	3,840	437	86	455	271
2- 5 years }	566	278	229	43	15,881	441	71	1,523	1,228
5-10 years	491	311	152	49	24,968	308	59	693	543
10-15 years	253	141	90	15	24,657	170	34	288	225
15-20 years	466	286	132	31	21,024	270	56	416	275
0-10 years	3,449	1,225	2,353	392	49,730	2,414	476	3,930	2,444
10-20 years	719	427	222	46	45,681	440	90	704	500
20-30 years	1,981	1,216	508	101	39,695	916	177	1,549	1,060
30-40 years	1,441	730	588	118	29,305	709	144	1,392	888
40-50 years	946	349	488	90	24,254	757	171	977	456
56-60 years	604	198	396	86	15,518	570	121	706	274
60-70 years	344	80	266	64	8,256	445	98	466	148
70-80 years	163	41	136	21	2,846	273	69	313	85
80-90 years	70	17	62	10	663	99	13	121	22
Over 90 years	22	4	31	4	195	52	5	44	14
Not stated	357	150	293	125	....	30	7	115	93
Total population:									
White	....	....	....	....	158,395	....	....	....	....
Colored	....	....	....	....	57,748	....	....	....	....
					216,143‡	....	....	....	....
Total deaths by all diseases	10,096	4,437	5,343	1,057	....	6,708	1,375	10,318	5,984
Deaths by yellow fever	3,107	2,709	5	1	....	1	....	4,046	3,870
† Deaths by other fevers, especially malarial	968	491	433	159	....	469	190	777	569

TABLE No. 13.—*Giving the population and the deaths in New Orleans by ages*—Continued.

	1879.		1878.				1879.			
			Yellow fever.		Malarial fevers.		Yellow fever.		Malarial fevers.	
	Total annual deaths.	Deaths for the three months August, September, October.	White.	Colored.	White.	Colored.	White.	Colored.	White.	Colored.
* Still-born	379	103	......	......	......	......	......	......	......	......
Under 1 year	1,115	219	53	5	40	15	......	......	13	15
1– 2 years }	161	54	111	11	43	11	2	......	5	7
2– 5 years }	227	56	863	38	196	29	4	......	8	6
5–10 years	132	37	379	22	95	19	1	......	7	4
10–15 years	97	29	176	14	26	6	1	......	9	3
15–20 years	127	33	216	9	21	7	3	......	8	3
0–10 years	1,635	366	1,406	76	374	74	7	......	33	32
10–20 years	224	62	392	23	47	13	4	......	17	6
20–30 years	520	138	875	34	57	12	4	......	20	9
30–40 years	588	126	683	25	52	11	1	......	26	1
40–50 years	594	136	284	11	45	12	3	......	24	6
50–60 years	526	95	120	6	31	8	......	......	18	1
60–70 years	439	97	32	3	14	7	......	......	7	1
70–80 years	313	57	14	2	7	4	......	......	5	2
80–90 years	105	20	1	......	2	2	......	......	......	......
Over 90 years	46	11	......	1	......	......	......	......	......	......
Not stated	32	5	56	2	5	......	......	......	1	......
Total population:										
White	......	......	......	......	......	......	......	......	......	......
Colored	......	......	......	......	......	......	......	......	......	......
Total deaths by all diseases	5,122	1,113	......	......	......	......	......	......	......	......
Deaths by yellow fever	19	16	3,863	183	......	......	19	......	......	......
† Deaths by other fevers, especially malarial	209	81	......	......	634	143	......	......	151	58

* The still-born are especially given because included in those "under 1 year, &c.," in 1857, '58, '59 1866, '67, '68, but excluded in 1877, '78, '79, from all the annual data of mortality.

† The fevers thus summarized were specified as follows: "Bilious, congestive, pernicious, malignant, typhoid, typhus, remittent, intermittent, Chagres, brain, nervous, and gastric fever." It is specially noteworthy that the first six always increased notably during every yellow-fever epidemic.

TABLE No. 14.—*Estimates derived from the data in the preceding table.*

	1858.				1867.				1878.			
	1858 compared with the average of 1857 and 1859.				1867 compared with the average of 1866 and 1868.				1878 compared with the average of 1877 and 1879.			
	Excess of deaths in 1858 over the average annual deaths in 1857 and 1859.	Excess of deaths in Aug., Sept., Oct., 1858, over the average of same months in 1857 and 1859.	Ratio of the average deaths in 1857 and 1859 to the population of 1860.	Ratio of deaths in 1858 to the population of 1860.	Excess of deaths in 1867 over the average annual deaths in 1866 and 1868.	Excess of deaths in Sept. and Oct., 1867, over the average of same months in 1866 and 1868.	Ratio of the average deaths in 1866 and 1868 to the population of 1870.	Ratio of deaths in 1867 to the population of 1870.	Excess of deaths in 1878 over the average annual deaths in 1877 and 1879.	Excess of deaths in Aug., Sept., Oct., 1878, over the average of same months in 1877 and 1879.	Ratio of the average deaths in 1877 and 1879 to the population of 1880.	Ratio of deaths in 1878 to the population of 1880.
Under 1 year	356	223	436.6	534.5	297	203	305.0	362.8	88	163	232.3*	249.7*
1–2 years }	100	122	......	......	88	110	105.4	126.5	156	201	77.8	118.5
2–5 years }	511	520	52.6	85.0	197	202	24.0	36.8	1,189	1,165	21.1	95.9
5–10 years	100	121	13.9	19.2	235	246	12.1	23.3	473	495	8.8	27.7
10–15 years	158	152	8.8	12.6	122	108	6.2	12.0	155	194	5.4	11.7
15–20 years	394	362	11.9	37.1	278	232	9.6	23.7	218	231	9.4	19.8
0–10 years	1,066	984	68.5	94.2	817	760	57.4	75.3	1,906	2,023	40.7	79.0
10–20 years	557	514	10.2	28.2	400	340	7.9	17.7	372	424	7.3	15.4
20–30 years	2,171	2,060	23.7	83.8	1,193	998	22.9	57.6	831	903	18.1	39.0
30–40 years	1,105	1,044	28.9	64.6	652	519	27.4	50.0	744	753	22.1	47.5
40–50 years	398	347	35.3	57.2	334	208	27.9	43.1	302	303	27.8	40.2
50–60 years	149	115	46.4	68.7	146	88	37.3	49.2	158	166	35.3	44 2
60–70 years	41	56	60.5	75.1	45	8	55.6	64.0	24	51	53.5	56.4
70–80 years	22	14	118.5	145.7	22	17	82.4	95.3	20	22	102.9	109.9
80–90 years	1	2	172.5	176.5	14	7	140.7	175.9	19	6	153.8	182.5
Over 90 years	......	1	238.9	150.4	......	1	193.5	142.0	......	6	251.3	225.6
Not stated	......	......	......	......	......	15	......	......	84	87	......	......
Excess of deaths:												
By all diseases	5,556	5,075	36.9	69.4	3,548	2,959	34.2	52.7	4,403	4,740	27.3	47.7
By yellow fever	4,710	4,399	.7	28.8	3,009	2,634	.0°	16.8	4,036	3,862	.0	18.7
By other fevers	281	222	2.4	4.6	414	292	2.9°	5.1	468	434	1.5	3.6

*It must not be forgotten that in order to make a rigid comparison between these figures for 1877' 1878, ar d 1879, and the corresponding ones for 1857, 1858, and 1859, and 1866, 1867, and 1868, the still-births should not be excluded, as they were from the former while included in the latter.

CHAPTER XI.

REMARKS ON CLIMATE IN CONNECTION WITH THE PREVALENCE OF YELLOW FEVER.

The National Board of Health has now in its possession the meteorological records of Havana for twenty years, recorded in the metrical system, and occupying hundreds of printed pages; and also the records for one or more years of several other places—in fact, of all of the few places in Cuba which have such records. It is possible that an expert in meteorology might, by thorough study of these records, and by their comparison with the statistics of yellow fever, add something to our present knowledge; but this is deemed highly improbable for the following reasons:

In the first place, a profitable comparison of the data of meteorology and of yellow fever would require an accurate daily record of cases, as well as of deaths, by the disease. In the next place, there are other causes than those of climate which greatly influence the disease, notably the daily varying amount of unacclimated persons exposed, and the varying quality as well as quantity of local insanitary evils, and it is indispensable that these and all other disturbing causes should be appreciable in order to appreciate duly the influence of climatic changes. Until public hygiene and its

handmaid, vital statistics, have made greater progress in the favored habitats of yellow fever, meteorological research should not be expected to prove any more fruitful than it has proved in elucidating the causes of the as yet inexplicable variations in the prevalence of disease—variations which occur equally and as inexplicably in the propagation of many vegetables and animals. Great labor and expense have been incurred in the effort to throw new light on the etiology of yellow fever by meteorological researches, which, however, have proved to be in large measure sterile, and at times even worse, since they have promoted many hasty conclusions and false inferences. None the less, some facts in reference to a subject which all concede has an important connection with yellow fever, seem to be imperatively called for in any consideration of the causes of the varying prevalence of yellow fever. Though no new facts can be given, some errors may be corrected.

TEMPERATURE.

This is conceded to be the climatic element of greatest importance, and the "annual mean" to be the chief factor. Throughout the West Indies the mean annual temperature, near the sea, is from 78° to 80°, the mean daily range is only about 6°, and the extreme annual range does not usually exceed 20°. At Havana the mean annual temperature varies in different years from 77° to 79°; the mean temperature of the hottest months, July and August, varies from 82° to 85°; and of the coldest months, December and January, from 70° to 76°. The minimum temperature is very rarely as low as 50°, and the maximum as rarely exceeds 100°; in fact, the thermometer, in the shade, seldom rises above 94°. There are no records nor any tradition of frost having ever occurred except on December 24 and 25, 1856. It is alleged that even in the sparsely inhabited mountains in the east of Cuba, where the Tarquino peak reaches an altitude of about 8,000 feet, frost rarely occurs, and snow never.

The influence of temperature on yellow fever is so decisive and well known that this influence is often exaggerated, and important facts concerning it are overlooked. The disease certainly does not select the hottest summers, and records like the following are numerous: Martinique escaped yellow fever in 1831–'33, when the heat was much greater than in 1838–'39, when the disease prevailed severely. Farther, though frost does not occur, yet as a general rule yellow fever in Havana declines in a marked manner by September, when the weather is still very warm; and the disease, though persisting, continues to decline, in spite of the fact that in September the number of the unacclimated arriving in Havana begins to increase; for it is certain that the number of passengers arriving from abroad begins to increase generally in September, always in October, and is always much greater during each of the seven months, October to April, than during any of the five months, May to September. (See Tables Nos. 27 and 28.) Hence the disease does not decline because of frost, nor, as a rule, because of a lack of unacclimated material in September and October.

But in Cuba and throughout the tropics there have been frequent exceptions to the rule. The disease has continued throughout the winter, and repeatedly there has occurred the usual marked decline in August, September, or October, followed by a recrudescence and severe prevalence of yellow fever during the coldest months. Five such winter epidemics, from October to February, occurred in St. Thomas from 1795 to 1833. They have repeatedly occurred at Vera Cruz and at Martinique. One occurred in British Guiana during the winter of 1852–'53; another at Santa Cruz de Teneriffe, Canary Islands, which began October 6, 1862, and ended in February, 1863; and there have been numerous winter epidemics in Cuba. These last have been carefully studied, as reported in the monthly statistics of the military hospitals since 1850, and of the Cuban superior board of health since 1855. The attending circumstances are not sufficiently well known to justify the accurate and valuable conclusions which should be deducible from such a study. None the less, these reports, taken in connection with such facts as are known, seem to prove three things: First, while a winter epidemic has been prevailing in Havana, the disease has often declined as usual at other infected places in Cuba, and *vice versa;* a result inexplicable by a difference in climatic conditions. Second, a large majority of these winter epidemics have been associated with a notable increase in the number of presumably unacclimated immigrants, certainly in the number of passengers arrived, and of patients admitted to hospital. Third, these winter epidemics have, however, occasionally occurred when there has apparently been no such increase, in fact even when a decrease in the usually large number of the acclimated seems to have occurred.

These results can only be explained by the conclusion that there are unknown local, perhaps in part climatic, conditions which are occasionally, even in tropical winters, favorable to the propagation of yellow fever; that if, during such favorable periods, the unacclimated material be increased, there will follow, of course, an increase of the disease; but that, on the other hand, however numerous the unacclimated may be, there will be no increase of the disease except during those rare seasons when the unknown local conditions are favorable. As is well known, neither meteorological

researches nor sanitary inspections have yet detected any exceptional climatic or insanitary conditions corresponding with exceptional epidemic periods, whether occurring in winter or summer.

Preceding conclusions prove that the propagation of the poison of yellow fever is subjected in Cuba, as everywhere else, to unknown local conditions, and are at variance with a common belief that the only thing necessary to bring about an epidemic in the West Indies is a large importation of unacclimated persons. There are many facts, besides those stated, to prove that although this is an all-important, and the most frequent condition, yet that it is not the only one necessary. In 1726 an English military expedition against Porto Bello, Darien, was ravaged by yellow fever, while a similar expedition in 1730 escaped. In 1741, an English expedition against New Carthagena, United States of Colombia, suffered severely with yellow fever, but a like expedition in 1815 escaped. In 1762, an English expedition against Martinique, also against Havana, was ravaged, but a similar expedition against Martinique in 1809 escaped. In 1861-'65, the French expedition against Mexico suffered there severely, yet from the middle of July to October, 1862, no less than 23,447 French soldiers, *en route* to Mexico, halted at Martinique, some as many as ten days, and others longer, without suffering at all with yellow fever, though subjected to insanitary conditions apparently most favorable to the disease; and the same thing repeated in subsequent years was followed by the same favorable result. In 1862-'65, New Orleans was occupied by numerous unacclimated Federal soldiers, but no epidemic occurred. In 1866, Havana and Cuba suffered remarkably little with yellow fever, so little that the Cuban superior board of health reported only 150 deaths for the entire island, yet official documents report an army, a navy, and a list of passengers arrived as numerous as in 1865 and 1867, when the disease prevailed severely. These few, among many similar facts, suffice to prove that wherever yellow fever habitually prevails, the crop of the poison, though this be certainly present, may be poor, notwithstanding that the climatic conditions, the insanitary evils, and the quantity of unacclimated material have all remained *apparently* unchanged.

Finally, as to temperature, the following facts prove that those exaggerate its influence who attribute the usual decline of the disease in Cuba, in the fall, solely to the diminished heat. Since, occasionally, severe outbreaks occur even in December and January, the coolest months; and since there is usually a marked decline in the disease about September, at the time when the number of passengers arriving from abroad increases (see Tables 27, 28), it cannot be claimed that this usual decline is due either to reduced temperature alone or to exhaustion of the unacclimated material. In New Orleans, as also farther north, yellow fever has repeatedly prevailed with great severity in October, which has a mean temperature as high as the winter months of Cuba. Even in Philadelphia the epidemic of 1793 reached its maximum in October, when the mean temperature of the month was only 62.5° F., with a morning temperature of 44°. Dr. Archibald Smith reports that in the epidemic, 1853-'56, in the Peruvian Andes, the disease prevailed severely at Cerro Pasco, 14,000 feet above the sea, and at a season when the mean temperature is only 44° F. Even if credence be refused the last extraordinary report, other facts abundantly suffice to prove that the mean temperature at Havana, at the period when yellow fever usually declines, is not incompatible with the growth of the poison.

RAINFALL AND HUMIDITY.

During the sixteen years, 1859-'74, the average number of rainy days at Havana was 113; the minimum number, 97 days, occurred in 1869, and the maximum number, 141 days, occurred in 1862. The average amount of rain for the sixteen years was 49 inches, the minimum was 42.5 in 1861, and the maximum was 70 inches in 1867. The maximum amount of rain falling in any one day was 8¼ inches on April 7, 1869. The so-called rainy season is from May to September, inclusive, but especially during August and September. The rain then descends with such rapidity that it runs off in torrents; but, as is seen, the usual belief that the annual rainfall is excessive is erroneous. The annual mean relative humidity varies in different years from about 73 to 74.5, and that of the different months of the year from 66 to 79; the minimum occurring in any day of the year may be as low as 34, and the maximum as high as 96. Evaporation is extremely rapid.

There is little reason to believe that in any tropical climate, where there is abundance of water for evaporation, there can ever be a lack of as much atmospheric moisture as the yellow-fever poison probably does require. While humidity has been assigned a prominent place in the causation of the disease, which does prevail specially in humid climates and seasons, it is none the less true that severe epidemics have repeatedly occurred when the humidity of the infected place was even less than usual. Dutrouleau reports as to Martinique, "often, after and during the dryest season, yellow fever has committed its greatest ravages," and Cornilliac details a list of epidemics which occurred during prolonged droughts. A severe epidemic occurred in New Orleans in 1841, recorded to have been an unusually dry year. La Roche (pp. 130-169, v. 2) and others cite numerous similar instances.

WINDS.

No connection has ever been established, though often attempted, between the prevalence of yellow fever and the prevalence of the wind from any special quarter. While there is evidence that storms or hurricanes exercise an unfavorable influence on those dangerously sick, there is evidence fully as convincing that such winds tend to dilute or drive away the poison, to diminish its activity, and thereby to reduce the number of cases attacked.

PRESSURE OF THE AIR.

Humboldt states that the range of the barometer is very slight, within half an inch. The average mean at Havana is 29.9 inches, and the mean of different seasons ranges from 29.6 to 30.03. The minimum may be as low as 29.4, and the maximum as high as 30.3, excluding hurricanes, of course. During the frightful hurricane of October 5, 1844, the greatest descent observed was 28.27 inches. The barometer has thrown no light as yet upon on the etiology of yellow fever. The disease is arrested at certain altitudes, but this is, no doubt, due to their low temperature, to their better exposure to winds, and to their inaccessibility and sparse population, rather than to diminished aerial pressure.

ELECTRICITY.

Repeatedly, as in New Orleans and the Southern States in 1878, violent epidemics have been attributed to the absence or infrequency of electrical storms, and to a diminution of the quantity of electricity in the air; probably even oftener the reverse has been maintained, for, at Vera Cruz, Martinique, and elsewhere, violent epidemics have been repeatedly associated with an unusual frequency of electrical storms.

MAGNETISM.

For a series of years the observatory of the College of Belen, in Havana, recorded the variations of terrestrial magnetism. In 1868, Dr. Poggio, medical director of the military hospital, Havana, made a careful comparison, day by day, of the variations in both yellow fever and terrestrial magnetism. "The result of a very careful investigation was total disappointment."

OZONE.

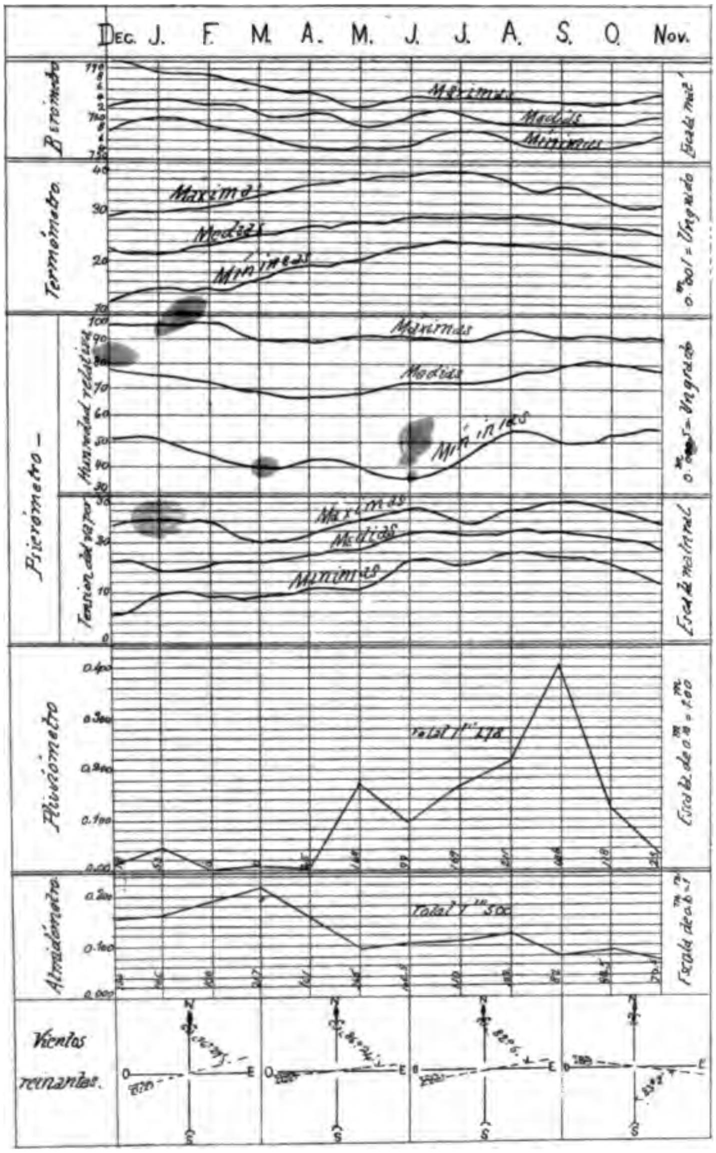
In the severe epidemic, from October, 1862, to February, 1863, at Santa Cruz, in the Canary Islands, ozonometrical observations were made, which appeared to prove an increase of ozone as the epidemic declined. Dr. Fuzier, chief of the French military hospital at Vera Cruz, 1861–1865, testifies to having "proved the feeble quantity of ozone in places which yellow fever prefers." Cornillac reports that insufficient observations at Basse Terre, Guadeloupe, in 1868, gave no conclusive results. Griffon du Bellay, reporting the epidemic of 1869 at Guadeloupe, states: "The ozonoscopic paper appeared to indicate, by its slight coloration, the absence, or at least the diminution, of ozone in the air. Careful scrutiny of the various shades of color seemed to mark out the moments of arrest and of recrudescence of the epidemic. But, unfortunately, subsequent observations did not confirm the earlier ones, and the only conviction left was that the ozonoscopic paper had simply followed in its changes the hygrometric condition of the air, a condition which has very obscure relations with public health. The ozonoscopic paper remained uncolored when the weather was dry, hot, and calm, and, on the contrary, became more or less colored when the weather was rainy, or the air was moist, or much agitated." No records of any observations other than the above have been found. These leave the conviction that the tests for ozone must be improved, and observations be often repeated, before any conclusions will be justifiable. Certainly nothing thus far has been proved.

ALKALINITY OF THE AIR.

Dr. Carlos Finlay, a chemist and distinguished physician of Havana, claims that he has detected a marked correspondence between the varying prevalence of yellow fever and the varying degrees of alkalinity in the air at Havana and several adjacent places. Dr. Finlay says "practical deductions would evidently be premature in the present state of the inquiry, yet it is believed that enough has been proved to induce a systematic investigation to be instituted, in order to compare the alkalinity of various localities at different seasons of the year, with regard to the influence of aerial alkalinity on the development of yellow fever."

All the facts which precede tend to show that science has thus far failed to prove the essential connection with yellow fever of any one meteorological factor, except heat; and that our knowledge, even as to this, is very indefinite respecting its requisite degree and duration. For reasons already stated, science is not likely, for many years to come, to be placed in fit condition to prove whether some peculiar combination, or some special recurrence of climatic conditions, may not be necessary for the growth of the poison.

Graphic Representation of Meteorological Observations recorded at the Observatory of the College of Belen, Havana, under the direction of R. P. Viñes



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Coronel de Ingenieros Rebolbena
Comandante de la Plaza de la Habana

GRAPHIC REPRESENTATION OF METEOROLOGICAL OBSERVATIONS.

CHAPTER XII.

GEOLOGY AND PHYSICAL GEOGRAPHY OF CUBA IN CONNECTION WITH THE PREVALENCE OF YELLOW FEVER.

Inasmuch as some have attributed to local geological peculiarities the habitual prevalence or absence of yellow fever, this subject deserves some little consideration, especially in reference to the character of the soil and to altitude. Although Humboldt's work is old, yet it is still the best authority on this subject, and from it are derived most of the following facts in respect to Cuba. There are two kinds of soil, and these are often intermixed like the squares of a chess-board, the black or brown soil, which is argillaceous, highly charged with sooty exhalations, and full of moisture, and the red earth, which is more silicious, and contains oxide of iron. The island is, in great part, composed of limestone rock; coral rocks, so abundant at Havana and on the seashore, are found on the highest mountains, and the accumulations of fragments of coral and of quartz sand are still daily augmented. "More than four-fifths of Cuba consists of lowlands, and its surface is covered with secondary and tertiary formations, through which granitic gneiss, syenite, and euprodite rocks have protruded." Volcanic rocks more recent than these have not been found. Syenite are often found alternating with serpentine rocks, while only one of these is found at some places; as, for instance, the serpentine alone at Guanabacoa. Hornblende, feldspar, and quartz are frequently found. "The central and western parts of the island contain two formations of compact limestone, one with sandy clay, and the other with gypsum." There have also been found in the western department granitic gneiss and primitive slate. Copper abounds throughout a great part of the island; more than 100 mines have been entered, and the one at Cobre is still worked with profit. Marble and loadstone are found in great quantities. Gold, silver, iron, &c., are to be found; so also veins of solidified asphaltum, but no coal.

The southeastern extremity of Cuba is very mountainous. These mountains encircle Santiago de Cuba; the highest range lies to the west, and the highest peak, Tarquino, exceeds 8,000 feet. Humboldt refers to the mountains as a "calcareous group," but Pezuela states that "the nature of the soil at Santiago de Cuba is more volcanic than calcareous." The general surface of the rest of the island—say four-fifths of it—is gently undulating, having a chain of hills, not generally exceeding 380 feet in height, running through it. However, there are here and there loftier heights, as, for instance, the Pan of Matanzas, 1,255 feet; but there are probably no other higher elevations west of Matanzas.

Pezuela states that Cuba has over 200 rivers, and specifies by name fifteen "principal rivers," which empty on the northern, and fifteen more on the southern coast. Few Cuban rivers are navigable; none of them for more than a very few miles. The half dozen "principal rivers" seen by me were no more than creeks, insignificant when compared with many even of the "bayous" of Louisiana. Evidently the Spanish word "rio" is used to include streams to which we would never apply the word "river." Referring to Cuban rivers, Humboldt wrote, "The cavernous texture of the limestone formations just described, the great inclination of the strata, the narrowness of the island, the nakedness of the plains, and the proximity of the mountains, that form a lofty chain on the southern coast (east of Cienfuegos), may be considered as among the principal causes of the want of rivers, and of the drought which is experienced, especially in the western part of Cuba. In this respect, Hayti, Jamaica, and several of the lesser Antilles, which contain volcanic heights covered with forests, are more favored by nature."

Although preceding facts totally fail to explain why Cuba is now the most favored habitat of yellow fever, or to throw any light on this disease; yet they may serve to restrict idle speculations and misleading theories. Intelligent students of this disease have repeatedly urged that its habitual absence from or presence at a place could be explained only by geological peculiarities. For instance, in Cuba some have ascribed the marked difference in the prevalence of yellow fever at Havana and at Guanabacoa (only about 3 miles distant) to the fact that Havana is built, for the most part, over very porous coral limestone, while Guanabacoa is built over the denser serpentine rocks; and some have also asserted that the disease avoids localities of volcanic or igneous origin. Neither of these views is correct. As is elsewhere shown, Guanabacoa has more yellow fever than it is credited with, and also a smaller unacclimated popu-

lation; and these facts serve to explain, in large part, if not wholly, the difference, less than supposed, which has been the object of speculation. In fact, the history of yellow fever fails entirely to justify the view that the geological peculiarities of a place have any notable influence on yellow fever. The presumption is reasonable that the more porous the soil the better the habitat for the poison, but even this much is inferred rather than proved. Cornilliac states that the question as to the visitations of the disease at Martinique is determined by the extent of its unrestrained commercial intercourse with infected places rather than by its proximity to such places, or by any other cause; and it is believed that if the commercial history of infected places should ever be thoroughly investigated and compared with their yellow-fever history, it would be conclusively established that this predominates in all such places over all other causes, and certainly over any influence of geological peculiarities. On this influence, attention is called to the following facts:

At present the three most important foci of yellow fever are Rio de Janeiro, Havana, and Vera Cruz, all of which differ geologically. "Vera Cruz is built on a sandy plain elevated a few feet above high-water mark," and yellow fever has repeatedly visited sand islands, such as Galveston, Tex., and St. Louis on the west coast of Africa. In Cuba, the five most important centers of the disease are Havana, Matanzas, Cardenas, Cienfuegos, and Santiago de Cuba. While Havana and Matanzas are very like geologically, the others differ from these and from each other; and Santiago de Cuba is said to be much more volcanic than calcareous. The Antilles have been divided into two great groups, volcanic and calcareous, yet the disease prevails in the one group as in the other. Morne Rouge, Martinique, has been several times visited, although a summer resort, 1,443 feet above the sea, and having a soil of pumice-stone, a porous volcanic product. The island of Gorée, some 90 miles from the sand island of St. Louis and the west African coast, has been visited when the latter, as also when Cape Vert have been visited, all three being French settlements in close communication with each other. Gorée is a very small island, a completely arid rock, without swamps, and very healthy, and is composed of volcanic black basalt and red ferruginous rocks. Cape Vert has no swamps, is very healthy, and is a plateau formed of ferruginous rocks superimposed on basalt.

In the earlier part of this century the rock of Gibraltar was repeatedly and severely visited. In fine, in the United States, as elsewhere, innumerable places have been ravaged, having such numerous varieties of geological structure that no one has ever been able to attribute to the poison of yellow fever any geological preferences. The frequent prevalence of the disease on ships proves that the growth of the poison is independent of geological conditions. That the disease should show preference for miasmatic water-soaked lowlands is chiefly attributable to the fact that such is the location of most tropical maritime cities; for there are numerous instances showing the power of the poison to flourish vigorously in non-miasmatic dry highlands.

The influence of altitude on the disease is as well recognized as that of climate, and, in fact, since "difference of altitude is equivalent to difference of latitude," the apparently two influences are, in the main, really the same. Experience in Cuba, respecting the influence of altitude, contributes nothing to present knowledge. The limited mountainous section has, as is usual in mountains generally, a very sparse population, which, because of poverty and bad roads, has very limited intercourse with infected places; hence, it is not strange that yellow fever does not prevail in these mountains, and that therefore the inhabitants are not acclimated, suffering with yellow fever on visiting infected places. But little doubt can be entertained that yellow fever could, under favorable circumstances, ascend these mountains, possibly even to the summit of Tarquino. During the insurrection, 1868–'78, these mountains were the theater of war, and the board of health at Santiago de Cuba reported that yellow fever visited encampments located more than 1,000 feet above the sea. It is well known that at about the same parallel, 20° north latitude, in Mexico, Cordova, 2,962 feet altitude, has suffered several times, and Las Animas, 3,308 feet altitude, has been visited, while Orizaba, 4,195 feet, and Jalapa, 4,330 feet, have never yet suffered,* although the sick and fomites have been certainly introduced repeatedly, and probably many times every year, by railroad from Vera Cruz. Yellow fever has several times visited Newcastle, Jamaica, about 18° north latitude and 4,200 feet above the sea. Dr. Archibald Smith, of Lima, recording the history of "yellow fever in the Peruvian Andes, 1853–'56," recounts its visits to not less than forty places in Peru, and among these to—

Huaras, about 9½° south latitude and 10,000 feet altitude.

Cuzco, about 13° south latitude and 11,380 feet altitude, with a mean temperature, in the shade, of about 60° F.

Lampa, about 15° south latitude and 12,805 feet altitude.

Puno, about 16° south latitude and 12,893 feet altitude.

Cerro Pasco, about 11° south latitude and 14,000 feet altitude, with a mean temperature in July, August, and September, when the disease prevailed, of 44° F.

* Dr. Heinemann, of Vera Cruz, wrote in 1879, as is believed correctly, that Jalapa or Xalapa has never yet suffered, while Parke's Hygiene, p. 480, teaches that the disease has there prevailed frequently.

These altitudes and temperatures, together with the fact that native red Indians suffered more even than Europeans by this epidemic, are very curious facts in the history of yellow fever, so curious as to justify the suspicion that the disease was not yellow fever. However, Dr. Smith presents much medical evidence, besides his own, in proof that the disease was yellow fever, and that competent medical officers, sent to inspect it in the mountains, found there the same well-known disease which had prevailed at Callao and at Lima.

Finally, it should not be forgotten that yellow fever is not the only disease influenced by altitude. Writing of plague, Parke's Hygiene, p. 487, states: "Elevation, as in so many other specific diseases, has a considerable effect; the village of Alwm Dagh, near Constantinople (1,640 feet above the sea), and freely ventilated, has never been attacked; the elevated citadel of Cairo has generally been spared; and when Barcelona was attacked the elevated citadel also escaped." Lebert states (Ziemsen's Cyclop.) that, in Europe, cholera has never ascended over 2,700 feet, nor, in southern countries, over 8,000 feet.

It may prove of interest to add that a decrease of 1° F. for every 300 feet of elevation, and a decrease of 1° F. in the mean annual temperature of places on the sea-shore for every degree of latitude from the tropics seem to be as close approximations to a general but variable rule as can now be made.

CHAPTER XIII.

IS YELLOW FEVER A FÆCAL DISEASE?

Parke's Hygiene teaches that yellow fever has "an evident connection with putrefying fæcal and other animal matters"; that "the localizing causes are evidently connected with accumulation of excreta around dwellings, and overcrowding"; that "it is highly probable that the vomited and fæcal matters spread the disease"; and that "it is now coming out, more and more clearly, that yellow fever—like cholera and typhoid—is a fæcal disease." As such a doctrine from so high an authority deserves consideration, the Spanish commission was solicited to contribute any facts likely to throw light upon the subject. Through said commission, one of its members, Dr. Carlos Finlay, made a report, from which are extracted the following statements:

"The chiefs of three night-soil establishments in Havana were interrogated. The experience of one dated from 1859 to 1879. He uses buckets for his work, and these with other utensils are kept in the house where the workmen live. He could not specify how many unacclimated workmen he had employed, but only three had been attacked. These had arrived from Spain August 22, 1865, and all had contracted yellow fever in from three to five weeks after arrival. All were severely attacked, but recovered after 10 to 15 days in bed in their usual dwellings.

"A second proprietor uses a pump and buckets, and his experience dates from 1862. He has never had yellow fever nor any other disease, though engaged in his present business since he was fourteen years old, having come to Havana when twelve years of age. A relative employed by him has enjoyed the same exemption from yellow fever. Without being able to specify other unacclimated workmen in his employ, he is none the less well convinced that he has had many of them, and that none of them ever had the disease while at work for him. He thinks that workmen exposed to privy-emanations during limited hours of work are probably less injured than those living in a house wherein such emanations are constantly breathed.

"A third proprietor also gave his testimony, which was valueless, as he had not had any unacclimated workmen. But in no establishment have I heard of any cases of yellow fever.

"From these facts it would seem that yellow fever is not a fæcal disease. The only three cases detected all recovered and manifested no aggravation of the disease. The respective owners of these establishments concurred in attributing prophylactic virtues to their uninviting occupation."

Surgeon Clements, U. S. A., reporting the yellow-fever epidemic in 1867 at the Jackson Barracks in New Orleans, specifies the scrupulous precautions taken as to the cleansing of privies, and the prompt disinfection of all stools, and states "it was recognized that these measures would tend to limit the liability to the disease and moderate its intensity; but during the whole epidemic I observed no fact which lent support to the suggestion that, like cholera, it might be considered a fæcal disease." (P. 125, Circ. No. 1, U. S. Surg. Gen'l's Office, 1867.)

As is well known, ships are a favorable habitat of yellow fever, yet these are presumably exceptionally free from fæcal and urinary deposits.

The privy system of New Orleans remains as it always has been—abominable—

consisting of mere pits in a supersaturated soil; and yet, since 1858, there has been a very marked diminution in the frequency of yellow-fever epidemics. From 1796 to 1859 cases of the disease occurred every year, and severe epidemics so frequently that these averaged not less than two in every five years, while since 1858 New Orleans has had only two serious epidemics, one in 1867, the other in 1878. However, during the twenty years—1859-'78—fæcal accumulations, and saturation therewith of the soil, must have increased annually. If yellow fever be a fæcal disease, it is difficult to understand why an increase of fæcal soil saturation and deposits should be accompanied with a decrease of the disease.

While preceding facts may be insufficient to prove that yellow fever is not a fæcal disease, they none the less deserve serious consideration by those maintaining the opposite view. Since inclosed, confined, ill-ventilated places, such as the holds of ships, trunks, barracks, &c., favor the growth of yellow-fever poison, privies and sinks may for this reason often prove foci of infection. Recent researches on germ-poisons prove that a deficient supply of oxygen notably favors the virulent growth of some of these poisons, while the abundant presence of oxygen lessens and destroys their virulence.

CHAPTER XIV.

INOCULATION OF "ROCIO," OR DEW, AND OF SNAKE VENOM AS ALLEGED PRESERVATIVES AGAINST YELLOW FEVER.

The following facts respecting the alleged protective power of inoculations of the dew of a locality infected by yellow fever deserve record, and are extracted from a report published in the "Anales" of the Havana Academy of Sciences.

In June, 1864, Drs. Lebredo and Cisneros, members of the academy, and distinguished physicians, tested the prophylactic values of inoculated dew, by request of Drs. Masnata and Fraschieri, who had claimed for it protective power.

"The substance used was not, as had been generally supposed, natural dew, but an artificial dew, obtained by the condensation of the vapor of water contained in the atmosphere of the closed room of a yellow-fever patient and collected on the surface of bottles containing water at a lower temperature than that of the surrounding air. After prolonged examination the following were our conclusions:

"Yellow fever is not a contagious nor an inoculable disease, hence the inoculation of dew cannot be effective. There is no such morbid entity as the so-called 'fever of acclimation,' and it has not been proved that the ailments thus designated protect from yellow fever. The symptoms succeeding the inoculation of rocio lack the uniformity necessary to constitute a classifiable pathological condition as dependent solely on the inoculation; the very slight intensity of the phenomena discredit their identity with those of the so-called fever of acclimation; in many instances no phenomena have ensued, and all the results obtained are explicable by disregard of hygienic laws. In three counter experiments distilled water was inoculated; in one case more remarkable results ensued than in any case inoculated with 'rocio'; in a second the results were as mild, and in a third case no results at all ensued. Finally, as the result of experiments, the inoculation of 'rocio' is ineffective, and equally as negative as inoculations of black and of bilious vomit."

In connection with this attempt, it is worth while recalling that a Dr. William Lambert de Humboldt, who claimed to be a nephew of the famous Alexander Humboldt, and who died in Vera Cruz in 1857 without having revealed his secret, professed that he had discovered a sure means, by the inoculation of the venom of an unspecified Mexican snake, to protect all from yellow fever. As is known, the venom of some snakes causes hemorrhages of the gums, etc., fever, a slow pulse, and other symptoms like those of yellow fever; hence the theory. Humboldt began his experiments in Vera Cruz in 1847 on condemned prisoners, and by permission of the government. Boudin states that the matter inoculated was an ounce of sheep's liver, bitten six times by six different vipers; left to putrefy, it was then inoculated.

In October, 1854, Humboldt, then in New Orleans, notified the captain-general of Cuba, Concha, of his alleged wonderful discovery. A commission to study the subject and to test the experiments made by Humboldt himself was appointed by the Spanish Government, and in addition a French commission came to Havana from Martinique. There were 2,477 persons inoculated from December 18, 1854, to June 28, 1855. In January, 1856, the Spanish commission reported that no good results ensued, and the general opinion of the medical profession thoroughly concurred with this official report.

CHAPTER XV

THE WARDS OF HAVANA WHICH ARE THE MOST AND THE LEAST UNHEALTHY AND INFECTED WITH YELLOW FEVER.

The city of Havana is divided into nine districts, and these are subdivided into thirty-six wards. About nine of these wards front immediately on the harbor and some five of them immediately on the sea; several are located more than 100 feet, others not 10 feet above the sea; some are well paved and drained, while others are neither the one nor the other; some are very densely, others very sparsely inhabited; some have a very small, others a large unacclimated population; and these wards when compared with each other present other differences of great importance to the sanitarian, differences which, if enlightened by vital statistics, would unquestionably enforce most valuable practical lessons. But the vital statistics, indispensable to such lessons, in respect to the different wards of Havana, are totally lacking, and the sanitarian is forced to listen to vague rumor and popular opinion, for which, in such matters, experience has taught him to entertain little confidence.

Common repute specially condemns the wards of Jesus Maria, Colon, Pueblo Nuevo, and Casa Blanca, and reports at least the first two as great sufferers by yellow fever; however, in respect to this it deserves notice that the alleged severer prevalence of yellow fever may be due to a larger population of poor, ignorant, unacclimated immigrants. The wards of Jesus del Monte, the Cerro, and Vedado enjoy the best reputation for salubrity and freedom from yellow fever. A few facts will be reported respecting these seven wards, and especially respecting the alleged exemption of three of them and of some other localities from yellow fever.

The portion of the city in worst repute is the fifth district, and especially Jesus Maria, one of its wards. This is, to considerable extent, reclaimed swamp lands, filled in largely with street refuse and garbage. It fronts the bottom of the harbor. Its rough unpaved streets are in many places almost impassable in wet weather, even to pedestrians. Great mud holes, covered with green slime and fit only for the abode of hogs, are numerous. The houses, as well as the streets, have an uncared-for, filthy, and disgusting appearance; and the sickly, anemic, residents look as dirty and cheerless as the streets and houses.

The Punta or Colon wards in the third district, at least the portions which immediately front the sea, have a reputation almost as bad as the Jesus Maria ward. The foundation rocks were, during the last century, excavated to build fortifications, and these excavations were filled up with street refuse and garbage, hence this ward is, like Jesus Maria, to some extent, reclaimed land. These portions are alleged to be very unhealthy, while houses, only six or eight blocks distant, are not so; comparatively light rains flood the banquets and run into the houses. The streets are wider and the houses better than in Jesus Maria. Some consider the location of the latter, at the bottom of the harbor, a chief cause for its unhealthfulness, but the unhealthy portion of the city now referred to fronts the sea.

The Pueblo Nuevo ward, still farther to the west, also fronts the sea, and is built on a slope which attains an altitude of nearly 70 feet. Notwithstanding these advantages, it is very badly drained, and has, as it apparently deserves, an ill repute for healthfulnesss.

Casa Blanca is the only ward of Havana which is located, as is the town of Regla. across the harbor on its eastern shore. It is near the entrance of the harbor at the foot of the hill on which is located Fort Carbañas, which is immediately adjacent to the Morro fort which commands the entrance. This village and its wharves have a very dirty dilapidated appearance and an ill repute for yellow fever. Very near by and only a few feet from the water's edge, ballast of earth and porous stone was once procured. This depot is little if at all used now. Ballast from this place deserves strong condemnation, but even more objectionable is the ballast so frequently obtained from the depot within the town of Regla.

The three suburban wards, Jesus del Monte, the Cerro, and Vedado, enjoy the best reputation for salubrity, and also for their freedom from yellow fever. Intelligent residents are readily found, who will assert with great assurance that no one is ever attacked in these wards except those who have been elsewhere infected.

The summit of Jesus del Monte has an altitude of 67 meters, or 220 feet, the highest point in Havana, or its immediate vicinity. However, there are few, if any, houses about the summit; the average level of the ward is only 80 feet, and more inhabitants live below than above this level. The natural drainage is excellent, the houses in the elevated portion occupy more ground, and are better ventilated than in Havana. Located in a commanding position, about 100 feet above the sea, is the cigar manufactory of Mr. Alvarez, a wealthy and very intelligent citizen, whose manufactory was visited in search of unacclimated residents. This establishment is remarkably

clean, spacious, well ventilated, and furnishes numerous workmen with excellent quarters. Mr. Alvarez testified that he then, August 17, 1879, had twelve unacclimated workmen, arrived during the year from Spain, and that no one of them had been sick; and that he could recall, during many years and among many unacclimated workmen, but one who had suffered with yellow fever, and that this one had contracted the disease by visiting the city. He attributed the escape of his workmen to their good diet, their well ventilated apartments, and to his influence in keeping them out of the city, which, however, they had the right to visit after 5 p. m., when they desired to do so. The large privy in this establishment was foul, as usual, and was never emptied except when full, about every five years.

Very few unacclimated persons live in the more elevated portions of this ward. Dr. Domingo Cabrera, a resident physician of the ward, stated that cases of yellow fever did sometimes occur even on the heights. In the lower portion of the ward there were many unacclimated Canary Islanders who suffered severely with yellow fever.

In respect to the exemption of Jesus del Monte from yellow fever, the Spanish commission reported "this is the most elevated ward in Havana, and here there have been the fewest deaths by yellow fever, because it is for the most part inhabited by natives. Those attacked in the highest parts of this ward have been infected in the central parts of the city. In 1878 there were 35 deaths by yellow fever in this ward, but 30 of these occurred in the Beneficia infirmary, and were brought from elsewhere, leaving only 5 fatal cases for Jesus del Monte itself."

The Cerro ward, on the adjacent hill, west of Jesus del Monte, reaches an altitude of 120 feet, and is built upon, from its base at the harbor, to its summit. The more elevated parts are inhabited by the wealthy, and this is the most aristocratic quarter of Havana. Here the houses, gardens, streets, drainage, &c., are unusually good. Seeking to determine the influence at this place of yellow fever on the unacclimated, the large match manufactory of Mr. Artiz, a city alderman, was visited on August 6, 1879. The sanitary conditions of this establishment and of its surroundings were as favorable as those at Mr. Alvarez's factory. The privy was full, and, as usual, without pipe or chimney for ventilation.

Mr. Artiz stated that he had in his employ during the past eighteen years several hundred unacclimated workmen, of whom only two had had yellow fever, and that both cases were fatal. He had at the time and annually has from 6 to 10 unacclimated men, fresh from Spain. None of these had been sick in 1879. He attributed the escape of his workmen from yellow fever to the excellent diet, the admirably ventilated rooms in which they worked and slept, to the medicine he gave them, and to the fumes of phosphorus. In respect to this very favorable evidence Dr. A. G. Del Valle expressed his incredulity, as also did Dr. Pardiñas, and believed that these workmen in manufactories, who subscribe in large number to the Beneficia or other infirmary, had in many instances been sick and had died with yellow fever in said infirmaries without the knowledge of the proprietors of the manufactories

Seeking for proofs, always difficult to procure in places very near the heart of Havana, of persons who, without having visited other places, had been seized at the Cerro with yellow fever, Dr. Lebredo reported that, with Dr. Pardiñas, he was called in consultation by Dr. Araujo, to see Donna Carmen Rivera, a native of Mexico. She arrived in Havana about October 15, 1878, and proceeded without delay to a country-house at the Cerro. Seldom leaving the house, and then for only a very short distance, she was violently attacked on November 30, and died on the 13th day with very pronounced yellow fever.

In respect to the prevalence of yellow fever at the Cerro, the Spanish commission reported that "this disease is endemic at the Cerro, specially in the lowest, dampest parts, nearest the harbor, and because in these parts there reside many unacclimated persons. In 1878 there were 14 deaths by yellow fever in the Cerro alone."

The Vedado ward, also reported exempt from yellow fever, consists of a number of scattered houses west of Havana, on the sea-shore. There are two aggregations of houses; the first is designated Vedado; and the second, Chorrera or Carmelo. The latter is at the mouth of the Almendares River and about 4 miles from the entrance to the harbor of Havana. A railroad to Chorrera skirts the sea-shore. This ward is only about 8 feet above sea level, but in other particulars enjoys the sanitary advantages of well-ventilated houses in spacious grounds, fine exposure to sea breezes, and an appearance of cleanliness and comfort such as characterize the higher parts of Jesus del Monte and the Cerro. Though situated so much lower, the sanitary reputation of Vedado, and especially of Chorrera, is equally as good as that of the two last wards. None the less, Dr. Burgess assured me he had attended several cases of yellow fever at both Vedado and Chorrera, and had good reason to believe that some of these had been contracted in these places, and not in the city. The number of the unacclimated in this ward is so small, and the difficulty is so great in finding out who of these few have not been elsewhere exposed to infection, that it could not be determined satisfactorily to what extent this ward might itself be infected with yellow-fever poison.

While in Havana, professional interest was aroused by the exceptional fact that an outbreak of yellow fever had occurred at the General Asylum for the Insane, located at Ferro, on the railroad, 10½ miles south of Havana. Dr. Casimiro, the director, kindly presented a valuable report from which the following facts are extracted:

The asylum is well located on elevated ground. The outbreak began July 27, and occurred among the civil guardsmen, the sisters, servants, and other employés. Of these, ten were attacked to September 13, leaving only two among them, who were unacclimated, unattacked to said date. Whether all of the insane patients were acclimated was not known, but none of these were reported to have suffered. Of the ten persons attacked, all had arrived from Spain since November, 1877, and six of them in 1879. The first alleged case was S. Valero, a civil guardsman, who had been on duty several months. He had been sent to the military hospital in Havana on July 20, with "gastric fever," was discharged July 26, and returned to duty at the asylum. Dr. Parlinas reported that "during his stay at the military hospital he was in communication with those sick with yellow fever, as all patients in this hospital are." On July 27 he was seized at the asylum with what Dr. Casimiro considered to be yellow fever; he was, on the 28th, returned to the military hospital, where he died on August 2 with what was diagnosed to be "pernicious fever." The second case was a servant-girl who sickened on August 10. She conversed occasionally with the civil guardsmen, who passed to and fro between Havana and the asylum, and of whom more in 1879 than in previous years were unacclimated. The succeeding eight cases all had communication either with persons coming from Havana or with preceding cases. Dr. Casimiro concluded that if yellow fever be contageous, then Valero imported the disease in 1879 into the asylum. The local conditions have been just the same as during the three preceding years, when there were no cases of yellow fever, although there were during said years unacclimated persons in the asylum, and these were in free communication with persons visiting Havana, and even visited Havana itself.

In connection with the alleged exemption from yellow fever in the preceding suburban places, it should be known that a like exemption is claimed for some places in the very center of the most infected portions of Havana. Information was solicited from the Spanish commission respecting the influence of seclusion in convents, etc., in protecting the inmates from the disease. A report was received through said commission on the subject, emanating chiefly from lady superiors, abbesses, &c., and too defective in details to justify scientific conclusions. None the less, the following statements possess some interest, and aid the interpretation, which should be placed on the claims, made by various places near to Havana, to exemption from yellow fever.

The report states that in all convents, asylums, &c., yellow fever has been known, except in those to be mentioned, but that "in those convents of nuns whose seclusion is complete, no case has terminated in death." There are mentioned the following three places:

The Convent of St. Theresa has received in all 22 unacclimated nuns, but there have been only 5 cases of yellow fever. The first case occurred about thirty-six years ago, "in a nun in transit"; five years later two young Spanish nuns were attacked, and within the past three years two nuns expelled from Guatemala were attacked; one of these two came from the steamer to the convent sick with yellow fever, and died, having been the sole fatal case in this convent; the second of these two was attacked six months later.

The Ursuline Convent, the smallest of all the convents, educates many girls and has repeatedly received unacclimated foreigners, yet "there has never been a single case of yellow fever known within it."

The Hospital of Paula, for women, is located directly on the harbor, and yellow fever certainly occurs all around it. The report alleges that many poor women have entered this hospital with yellow fever and here died with it, yet, that throughout the past, so far as known, and this is certainly known since 1854, not one of the unacclimated Sisters of Charity, nor of the employés, nor of the servants has ever been attacked within the establishment.

The report, making the above statements, was not received by the American commission until about to return to the United States, and too late for further investigation, which, if practicable, would have been directed to the history of those alleged to be unacclimated, and especially in reference to their attacks of bilious remittent, pernicious typhoid, typhus, and other such fevers. After such an investigation had decided whether the statements made were facts, it would have been time to investigate the causes of any such extraordinary facts, and to give credence to such statements.

For additional facts respecting the alleged exemption of certain localities from yellow fever, see the special reports on Guanabacoa, Marianao, and San José de las Lajas, Chapters XLI, LI, LXVII.

CHAPTER XVI.

DENSITY OF POPULATION IN HAVANA AND OTHER CITIES.

Common experience long since established the fact that sickness and mortality increases, especially by epidemic diseases, with the aggregation of people in close quarters. Dr. Wm. Farr, in the Fortieth Annual Report, published in 1879, of the registrar general of England, confirms this truth by accurate statistical researches, and proves that, in England, the nearer people live to each other (within certain limits, reached in all cities), the shorter their lives, unless counteracting agencies, especially to purify the air, are brought into action.

Three tests are now used to determine the density of a population, viz: The average number of inhabitants to the house; the average number to the acre; and the "proximity" of the inhabitants to each other, supposing all the inhabitants to be stationed over the given area, at equal distance from each other. These three tests will be used to determine the density of the population of Havana, as compared with some other cities.

The average number of inhabitants to each house is a common but fallacious test, owing to the great differences in the average size, number of stories, and space occupied by houses in different cities. In all three of these particulars the houses in Havana are less favored than in any other city known to me. More than two-thirds of the population live in houses built in contact with each other; the average house-lot does not exceed 25 by 112 feet in size; and of its 17,259 houses, there are 15,494 one-story, 1,552 two-story, 186 three-story, and only 27 four-story houses, with none higher. At least 12 out of every 13 inhabitants live in one-story houses. The total civil, military, and transient population exceeds 200,000, and therefore the number of inhabitants to these very inferior houses is not less than twelve to each house.

Although houses in the cities of the United States excel those in Havana in all three particulars mentioned, yet, in 1870, the average number of inhabitants to dwellings in the fifty largest cities of the United States was only 6.78. There were only 6 cities which ranged as high as from 8 to 10 persons to the dwelling, and only one which exceeded this, viz, New York, with its numerous many-storied houses. The United States census of 1870 assigned to New York 14.72, and the State census of 1875 15.9 inhabitants to each dwelling. In 1870 the minimum number in any city was 5.2, and the numbers in the cities most frequently visited by yellow fever were as follows: Charleston, 7.14; Savannah, 6.18; New Orleans, 5.69; Mobile, 5.58.

The following table supplies the data necessary to test the density of population by the number of inhabitants to the acre, and by their "proximity" to each other. The data are somewhat unsatisfactory, except as to Havana and New Orleans; inasmuch as no distinction is made in respect to those parts (of the cities mentioned) which are densely, and those sparsely populated. So far as New Orleans is concerned its municipal limits are very extensive (occupying 150 square miles), and on the greater portion there are no houses, hence only one of its most densely-inhabited districts is cited.

TABLE No. 15.

Places.	Date.	Population.	No. of persons to acre.	Proximity. In yards.	Proximity. In meters.	Remarks.
Havana:						
Nine districts of	1877	179,473	17.8	16.5	15.	The figures given are estimated from the data furnished by Messrs. Ariza and Herrera, city engineers (see Table No. 18). These data for population exclude the military population, and are, for the civil population, less than those officially reported to the United States commission by all other authorities.
first to sixth districts	....	141,105	117.	6.4	5.8	
Old city, first and second districts	....	39,880	134.4	6.0	5.5	
third, fourth, fifth, sixth districts	....	101,225	111.0	6.6	6.	
seventh, eighth, ninth districts (suburban)	....	88,368	4.4	33.	30.	
New Orleans:						
Second district to Hagan avenue	1880	40,385	32.1	12.3	11.25	
sixth ward of second district	....	5,115	52.1	9.7	8.9	Only the oldest and most densely populated district of New Orleans and its most crowded ward and square are given. Data from Dr. W. H. Watkins,
square 72 of fifth ward of second district	....	310	145.5	5.8	5.3	
New York	1878	....	....	....	10.64	
Philadelphia	1878	....	....	....	21.02	

TABLE No. 15—Continued.

Places.	Date.	Population.	No. of persons to acre.	Proximity.		Remarks.
				In yards.	In meters.	
Twenty-three towns of Great Britain			88.			sanitary inspector. Total population of New Orleans in 1880, 216,143; total area, 150 square miles.
Greater London	1878				21.65	
Lesser London	1878				9.92	
Liverpool	1878		102.		6.76	
Manchester	1878		84.		7.46	
Edinburgh	1878		53.		9.39	
Glasgow	1878		94.		7.05	
Dublin	1878				12.21	
Alexandria	1878				17.44	
Amsterdam	1878				7.40	
Berlin	1878				8.19	
Bombay	1872				9.29	
Brussels	1878				7.70	
Naples	1878				11.56	
Paris	1876				6.73	
Rome	1878				7.60	
Vienna	1878				9.87	

NOTE.—The data for all places except Havana and New Orleans are taken from Dr. Farr's table.

CHAPTER XVII.

HISTORY OF THE FIRST APPEARANCE AND ANNUAL PREVALENCE OF YELLOW FEVER IN HAVANA AND CUBA.

The earlier the history of an epidemic be sought, the less conclusive of its non-existence becomes the absence of records in regard to it, and in this connection it should be remembered that the first newspaper established in Havana was the Gaceta de la Habana in 1782, while no medical journal was published until many years subsequently.

The historical records are as follows:

1648. "In this year there occurred in Havana, and in the fleet of Don Juan Pujados, a great '*pest of putrid fevers*,' which remained in the port almost all the summer. A third part of the garrison and a larger part of the crews and passengers in the vessels died."—(Pezuela, v. 3, p. 23.)

1649. "In the spring of 1649 an unknown and horrible epidemic, imported from the continent of America, caused consternation in Cuba. The 'Unpublished History of the Island' says: 'A third part of its population was devoured, from May to October, by a species of putrid fever, which carried off those attacked in three days. In the capital [Havana], where the governor, Villalva, came near dying, there died, at short intervals, the counselor of the governor, Francisco de Molina, and the lawyers Pedro Pedroso, Fernando de Tobar, and Pablo de Olivares, who successively replaced each other. By this can be judged the ravages which the *contagion* must have inflicted on other classes and towns. In that of Santiago [de Cuba] it increased during the following summer, so that the people fled for safety to the country."—(Pezuela, v. 3, p. 182.)

1653–'54. "The epidemic was renewed with equal fury during this time, in spite of precautions taken to prevent communication between the towns, which were, however, better protected by their distance from each other, and by the bad roads, than by these precautions."—(*Ib.*, v. 3, p. 182.)

1654–'55. "This was an epoch of rivalry and disasters. In the capital the pest continued to carry away its victims, without regard to rivalries and passions."—(*Ib.*, v. 3, p. 183.)

When it is considered that in the early history of yellow fever it was most frequently designated "the pest," that the above scanty records indicate some of the characteristics of the disease while omitting any contra indications, and that historical records prove the existence of the disease during some of the years, 1648–1654, in Barbadoes, Guadeloupe, Martinique, St. Cristophe, and probably in San Domingo, "the cradle of yellow fever," it is difficult to disbelieve that yellow fever did visit Cuba, as an epidemic, during the above recorded years. This probability renders still more remarkable the fact that, after 1654, no other historical indications of yellow-fever visitations to Havana are to be found until 1761, more than one hundred years.* On the contrary,

* The municipal board of health at Santiago de Cuba, 600 miles southeast from Havana, reported in 1879, "some assert that yellow fever first appeared here in 1686, imported from Martinique, but the most reliable data state that the disease was not known here until 1745–1748."

there are repeated records of the great salubrity of the climate and the absence of epidemic diseases. Among such records it will perhaps suffice to quote the following, written in 1760: "The experience of the benignity of its climate, favorable even for strangers, caused it [Havana] to be, from the first, a desirable residence for Europeans." —(P. 128, v. 1, Arrate's Hist.)

1761. "Although Havana is situated on the northern boundary of the Torrid Zone, it was very justly considered one of the most healthy localities on the island before its invasion, in a *permanent manner*, by the vomito negro [yellow fever], imported from Vera Cruz in the summer of 1761."—(Pezuela, v. 3, p. 19.)

"In May, there came from Vera Cruz, with materials and some prisoners destined for the works on the exterior fortifications of Havana, the men-of-war Reina and America, which communicated to the neighborhood the epidemic known by the name of the 'vomito negro.' At the end of the following June there were stationed in this port nine men-of-war, dispatched from Cadiz, and sent to the chief of the squadron, Don Gutierre de Hevia; they brought a re-enforcement of 2,000 men. To the epidemic, more than 3,000 persons succumbed on this, *the first appearance* of the vomito; from May to October occurred the greater number of victims in the garrison and in the squadron."—(Pezuela, v. 3, p. 27.)

"Of these two great morbific invasions—the introduction of yellow fever in 1761, and of cholera in 1834*—*the former remained endemic*, while the latter, more fatal, disappeared in the year of its first appearance, and did not reappear here until 1850, when it also reappeared in many other parts of America."—(Pezuela, v. 3, p. 164.)

The high authority of Pezuela as a most laborious and careful historian renders it unnecessary, it is believed, to cite other authorities which might be quoted in proof that yellow fever made its first appearance, so far as authentic historical records prove this, in the year 1761—not in 1762, as so often stated. That the disease has been "endemic" or "permanent" in Havana since 1761 is most positively asserted in the above quotations, but the subsequent prevalence of the disease is a subject of sufficient importance to give interest to the following quotations and facts:

1762. The English general, Lord Albemarle, and Admiral Pockock, with some 14,000 soldiers and 18,000 sailors, besieged Havana June 6, capturing it August 14, 1762, and restored it to Spain July 6, 1763. The authorities are numerous to prove that Havana suffered severely by epidemic yellow fever in 1762; only one of these will be cited, the one who is apparently responsible for the error that this was Havana's first epidemic. Surgeon Romay, the first physician of the Havana Military Hospital, and who had apparently resided in Havana since 1792, wrote in 1797: "Vernon's English squadron arrived, infected with yellow fever, in the bay of Guantanamo [in the extreme southeast of Cuba] in 1741. *I ignore if we had known it in Havana before* 1762. Then it committed its greatest ravages in the conquering English army and navy, who suffered from it even after their return to North America, according to Mr. Adair." —(Pp. 62–4, v. 3, 1877, Cronica Med.-Quir. de la Habana.)

Notwithstanding the scanty records of yellow fever at this date, history none the less registers the occurrence of a yellow-fever epidemic, in an English expedition which captured Martinique, also in 1762, and the prevalence in this same year of the disease in Vera Cruz, New York, Philadelphia, and Charleston. Pezeula says it was at Vera Cruz in 1761, in which year it was also at Charleston.

1765. "On June 30 the Conde de Ricla was relieved by Field Marshal Don Diego Manrique, who died with vomito July 13."—(Pezuela, v. 3, p. 51.)

1779. In July and August there arrived from Spain, because of its war with Great Britain, "an army of 3,500 men, who were immediately decimated by the vomito." —(*Ib.*, v. 3, p. 52.)

1780. On the 3d to 5th August a large squadron brought an army of 8,000 men. "In the two following months they suffered a loss of about 2,000 men with the vomito" (*ib.*, v. 3, p. 52); and Surgeon Romay reports, "the same epidemic was renewed in 1780, there being in this city an armament and numerous garrisons on account of the war with Great Britain."

1781. The Spanish army, gathered to rescue Pensacola from the English, was attacked with yellow fever.—(Pezuela, v. 1, p. 199.)

1793. Moreau de Jonnés reports that "public documents" prove the prevalence of yellow fever in Havana in both 1793 and 1794.

1794. "On the 9th of June the squadron of Aristizabal returned to repair damages at this port, where had arrived from Cadiz, as re-enforcements, four ships, with the chief of squadron, Don José Ulloa. The vomito appeared so severely this summer that, solely of the garrison and of the squadron, more than 1,600 victims were taken, one of these being Ulloa. It was indispensable to resort to a general levy to replace the losses on the vessels."—(Pezuela, v. 3, p. 53.)

In reference to this same epidemic Dr. Romay reports several facts, which, though

* Pezuela, v. 1, pp. 207–8, corrects this date, stating, in accord with other authorities, that cholera was specially severe in Havana from February 25 to April 21, 1833, and had almost disappeared by April 1834.

irrelevant to the present historical record, are of sufficient interest to be cited: "Finally, in June, 1794, after the ships which had been in Ocoa and Bayaha had entered this port, yellow fever repeated itself with great violence, attacking not only sailors and European troops, but also many native Americans of other provinces and of this country. There were some who thought that this epidemic had been caused by importation of the contagion on two frigates, one English, the other Anglo-American, which had arrived from the colonies of the north, then stricken with this disease. But before the said vessels had arrived in this port many had died with black vomit in the hospitals; and farther, the crews of these vessels had arrived healthy, and so remained until at least sixteen days after their arrival. Yellow fever specially prevails here, as elsewhere, in June, July, and August, although some cases have occurred even in the winter. The terrible hurricane which visited us on August 28, 1794, purified the air and gave us a new atmosphere. It dispelled the epidemic and relieved the sick much more than did all the efforts of medicine. It being impossible for me to visit on such a day those in my charge at the hospital, the hurricane preventing me from even supplying them with appropriate aliment, I expected to find them in the most deplorable state. But, to my great joy and astonishment, I found some perfectly well and others very nearly so." Dr. Romay adds that Moultrie reported a like experience in Charleston, September 21, 1745; and, as to the hurricane of August 28, furnishes the following meteorological data, the earliest yet found recorded: August 25, 1794, the thermometer at 4 p. m. was 87.5°; on 26th, 12 m., 88°; 27th, 6 a. m., 86°; 28th, 12 m., 81°; 2 p. m., 81.5°; 3 p. m., 82°; and 10 p. m., 81.5°.

After 1794, the first historical records found begin with 1805; some of these contain facts in regard to the sanitary condition of Havana which deserve record.

Mr. Henry Hill, United States consular agent at Havana, reported in 1806 (pp. 113–117, vol. 10, Medl. Repository) that, although yellow fever caused a great mortality among American seamen in 1805, yet this mortality was "not great compared with some former seasons." "It is from June to November that the fever is most prevalent and fatal. Indeed it is seldom known at any other seasons." "The streets are mostly unpaved, without sufficient descent to carry off the water lodged by the rains, and no attention is paid to the cleanliness of the city or to the health of the inhabitants by the police. The manner of depositing the dead in the churches (which is now interdicted by the bishop, he having caused to be built a cemetery [the cemetery of Espada, opened in 1806] without the city for that purpose) has been supposed greatly to affect the health of the inhabitants. The streets are filled with mud and filth; the back yards accumulate dirt and nauseous matter, and are never perfectly cleansed, and the privies are kept in them, together with mules and dogs; and many yards have cisterns which are very unwholesome. From all these causes clouds of putrid exhalations are formed in the atmosphere. No wonder, then, during the summer months, when the sun is nearly vertical, rains frequent, and the winds changeable, that so populous a city should be unhealthy. Indeed, I think, it would be uninhabitable were it not for the blessing of a pure sea air that occasionally mixes with and corrects its fetid atmosphere."

Humboldt, who visited Havana in 1800 and 1804, describes the streets as unpaved, filled with mud, almost impassable in wet weather, and to be traveled only in carriages or on horseback. He further says, "during my residence in Spanish America few of the cities presented a more disgusting appearance than did Havana from the want of a good police. One walked through the mud to the knees," &c. "There, as in many of our older cities in Europe, the adoption of a bad plan when laying out the city can only be slowly remedied." The city proper "is surrounded by walls, is about 1,900 yards long by 1,060 yards wide (416 acres), and yet there are piled in this narrow space 44,000 people, of whom 26,000 are blacks and mulattoes."

Codinach, p. 25, v. i, "Tratado del Vomito, Habana, 1868," writes: "Since then (1816) yellow fever exists with more or less intensity *every year* in Havana, Santiago de Cuba, Matanzas and other places on the coast of Cuba." And he states that from 1808 to 1816 yellow fever had rested its ravages for lack of fuel, but that in 1816 the landing of numerous people, and the arrival of successive armed expeditions became frequent, so that an epidemic broke out, "just as always heretofore as fast as new-comers arrived."

Dr. J. F. Cruzado, in his "Memoria sobre la Fiebre Amarilla endemica en la Isla de Cuba," 1855, writes, that after a continuous residence in Santiago de Cuba, Trinidad, and Habana, since 1821, the yellow fever appears in Cuba "almost annually as an endemic."

Dr. José Fernandez de Madrid delivered an address in Havana in 1822, published in 1824, in which he stated that yellow fever and dysentery are both "endemic diseases" in Havana.

Reporting on the severe epidemic of 1837 in Havana, Dr. Maher (pp. 99–115, v. 4, Bultn. de l'Acad. de Méd. Paris) wrote that yellow fever "reigns *all years* at Havana, almost from one end of the year to the other;" that the water of the harbor holds in

solution a vast quantity of putrid matters, and that the unpaved streets are extremely filthy.

Dr. Chas. Bélot details with indignant emphasis the particular insanitary conditions of Havana, and testifies that his experience extended back more than twenty years, *i. e.*, since 1845 at least, during which time yellow fever was present every year, and was "endemic."

The statistics published in this report to the United States National Board of Health date back to 1851, and conclusively prove the annual prevalence of yellow fever from that date to the present time, not only in Havana, but also in numerous other places in Cuba.

So far as Havana is concerned, the statistics, published herewith, together with the official manuscript reports of the military hospitals in Havana, and of the Cuban superior board of health, prove much more than the annual prevalence of yellow fever; for they prove that, during the 408 months, from January, 1856, to January, 1880, there was but one single month, viz, December, 1866, exempt from an officially reported case of the disease. Now, the combined reports referred to begin only with 1856, and they refer from 1856 to 1869 solely to the military and civil hospitals, exclusive of the very numerous cases of yellow fever in the preponderating civil population not treated in the hospitals; hence, the facts stated justify the conclusion that yellow fever has prevailed in Havana *monthly*, not only for the past twenty-four years, but also, in all probability, for many years anterior to 1856.

The historical evidence now concluded leads to the belief that while Havana did probably suffer from yellow fever, 1648–1655, yet that this disease failed, until 1761, to commit such ravage or gain such foothold as to compel its historical record, and that since 1761 it has annually, and during many past years, monthly, prevailed.

These conclusions incited two researches: first, in reference to the prevalence of yellow fever in other places prior to the establishment of one of its permanent domicils in Havana; and, second, in reference to the causes which, on the one hand, delayed its appearance in Cuba, and, on the other hand, rendered its domiciliation there so continuous and so disastrous both to Cuba and to other places maintaining constant commercial intercourse with Havana and other Cuban ports. These subjects will be considered in the next two chapters.

CHAPTER XVIII.

CHRONOLOGICAL SUMMARY OF THE GEOGRAPHICAL DISTRIBUTION OF YELLOW FEVER, 1492–1762.

The importance of this subject has been so conclusively demonstrated by such works as Hirsch's Geographical History of Disease that it is to be hoped the day is not distant when science will be placed in possession of as complete a record of yellow-fever invasions as the imperfections of history may permit. In the mean time, the following contribution, though imperfect, has the merit of being more extensive, and at the same time more accurate, as is believed, than any similar contribution referring to the same period, 1492–1762.

In 1820, Moreau de Jonnés presented the first valuable contribution to the geographical history of the disease; this was succeeded by Hirsch's chapter on the subject in 1860. Cornilliac has given the best summary respecting the Antilles, Féraud as well as Cornilliac respecting Martinique, and Toner respecting the United States. All of these contain errors, many of omission, some of commission. Some of these have been corrected in the following list, but it would be impossible to present an absolutely correct list, unless reference were made to the innumerable original sources of information, and unless the Spanish and Portuguese literature of yellow fever were thoroughly investigated.

As is well known, the descriptions of yellow fever are very unsatisfactory until about 1635, hence all dates earlier than this must be regarded as highly probable dates of yellow fever epidemics, but not as absolutely certain dates. Even after 1635 many epidemics are described with equal obscurity. The most doubtful dates will be followed by a point (?) of interrogation.

It is important to remember that very many of the dates refer to disastrous epidemics, while in other unrecorded years there is much evidence to prove that the disease did repeatedly occur to some extent sporadically, if not epidemically. This is notably the case as to San Domingo, Jamaica, Barbadoes, Martinique, and Guadeloupe, which were for many years prominent in war or commerce.

TABLE No. 16.—*List of places and dates of the prevalence of yellow fever, 1492–1762.**

WEST INDIES.†

Island.	Date of first settlement by Europeans.	Year of occurrence.
Antigua	1629	1706.
Barbadoes	1646	1647, 1665, 1691, 1693, 1694, 1695*g*, 1696, 1699, 1701, 1706, 1715, 1720*g*, 1721, 1722*b*, 1723, 1724*c*, 1733, 1740*g*.
Curaçoa	1634	1750, 1760.
Cuba	1511	1648–1655?, 1761, 1762. Pezuela, &c.
"English Antilles"	....	1701.
Grenada	1650	1694.
Guadeloupe	1635	1635, 1640, 1648, 1653. Has generally suffered when Martinique did, but not as well recorded.
Jamaica	1509	Epidemics reported during "first years" of its settlement, also in 1691, 1704, 1750.
Martinique	1635	1641*c*, 1648*c*, 1649*g*, 1651*c*, 1652*c*, 1653*c*, 1655*c*, 1669, 1682–1708*c*, 1720–1735*c*, 1749–1755*c*, 1762*a*.
Montserrat	1632	1690.
Niéves	1628	1706.
Porto Rico	1508	1508, 1513*d*.
San Domingo	1492	1493?, 1494, 1495, 1496, 1503, 1508, 1514, 1533, 1554*d*, 1560*d*, 1567*d*, 1580*d*, 1583*d*, 1585, 1586*d*, 1623*d*, 1642*d*, 1660*d*, 1685, 1686*e*, 1690, 1691, 1705, 1708, 1733–1744, 1746*b*, 1755. "18 disastrous epidemics 1700–1800."—Codinach.
St. Cristophe	1625	1648, 1652, 1653.
St. Croix	1640	1640.
St. Lucie	1639	1691*a*.
St. Thomas	1650	1702.
Bermuda	1609	1699*f*.

* Dates referring to the Antilles, and having no letter or other reference attached thereto, are cited on the authority of Cornilliac; for the most part in Part II of his work of 1867. Like dates referring to the United States have the authority of Toner in the Annual Report, 1873, U. S. Marine Hospital Service. The dates which are lettered are cited on the authority of the following:

a. M. de Jonnés.
b. Hirsch.
c. Féraud.
d. Codinach.
e. Pym.
f. Smart's Y. F. Epidemics of Bermuda, 1863.
g. Am. Ed. Cyclop. Pract. Med., 1845; Art., Yellow Fever.

Most of these authors refer to the original sources from whence they derived their information; and the full titles of the books unspecified above will be found in the biographical list of this report.

† There are no records of the appearance of yellow fever until after 1762 in the following islands, viz: Dominica, though settled in 1660; Tabago in 1634, Tortola 1650, and St. Vincent, though settled in 1660. Trinidad, settled in 1797, has had very few epidemics.

List for Continental America, exclusive of the United States.

Places.	Years.
Vera Cruz, Mex	Founded in 1519, and Tejada says yellow fever probably ever since then; since 1699, says Father Allegre; since 1679, says Heinemann, who, after quoting the above, states that yellow fever has since been endemic, and absent very few years, with frequent violent epidemics.
New Grenada, or United States of Columbia:	
Carthagena	1729*a*, 1741 (Moseley), 1744*a*.
Porto Bello	1729*e*.
St. Martha	1729*a*.

List for Continental America, exclusive of the United States—Continued.

Places.	Years.
Darien:	
Panama	1514, 1518?, 1740.
St. Maria	1514.
Guyaquil	1740.
Brazil	1643? and succeeding years, Codinach. Brazil first discovered in 1500. First opening of gold mines in 1684. Diamond mines discovered, 1730.
Pernambuco	1684, Cornilliac and M. de Jonnés; 1686, Cornilliac and Mélier; 1689, "N. O. Santy. Comn. Rept., 1853," p. 160; 1687 to 1690, La Roche, p. 211, v. 2.
Bahia	1687 to 1690, La Roche, p. 211, v. 2.
Rio Janeiro	1687 to 1690, La Roche, p. 211, v. 2.
"Coast of Brazil"	1744 to 1748?, "N. O. Santy. Comn. Rept., 1853," p. 160. No reoccurrence until December, 1849, since when it has annually prevailed.

List for Spain and Europe.

Places.	Years.
Cadiz, Spain	1643d, 1645d, 1647d, 1684d, 1705a, 1731a, 1732d, 1733a, 1734a, 1736a, 1744a, 1746a.
Malaga, Spain	1741a.
Minorca	1744a, 1747a, 1748a
The Cyclop. Pract. Med. presents some evidence justifying the suspicion that epidemics at the following places and dates may have been of yellow fever:	
Barcelona	1497, 1501, 1515, 1589, 1621d.
Saragossa	1564.
Spain*	1600, 1621.
Cadiz, Seville, Carthagena, Alicant, and Valencia	1648.
Gibraltar	1649, 1727.
Malaga	1678, 1679.
Lisbon, Portugal	1723a (1649g, 1736g?).
Rochefort, France	1694a.
West coast of Africa, Senegal	Settled by the French in 1635. "1759 or 1760" is the earliest record, found by Féraud, of the occurrence of yellow fever.

*During 1800 to 1845 not less than 89 places in Spain suffered with yellow fever.

List for the United States.

Places.	Years.
Albany, N. Y	1746.
Biloxi, Miss	1702.
Boston, Mass	1693.
Catskill, N. Y	1743.
Charleston, S. C	1699, 1700 (McClelland), 1703, 1713 (McClelland), 1728, 1732, 1734, 1739, 1741 (Moultrie), 1745, 1748, 1753, 1755, 1761, 1762.
Holliston, Mass	1741?
Mobile, Ala	1705.
New Haven, Conn	1743.
New York, N. Y	1668?, 1702, 1732, 1741, 1742, 1743, 1745, 1747, 1748, 1762.
Norfolk, Va	1737b, 1741a, 1742b, 1747.
Philadelphia, Pa	1695, 1699, 1732, 1741, 1742, 1743, 1744, 1747, 1760b, 1762.
Stamford, Conn	1745.

TABLE No. 17.—*List of dates and places, excluding those most doubtful, of the prevalence of yellow fever,* 1492-1762.

Years.	Places.
1494-'96—3 years	San Domingo.
1503	San Domingo.
1508	San Domingo and Porto Rico.
1513	Porto Rico.
1514	San Domingo, Panama, St. Maria.
1533, 1554, 1560, 1567, 1580, 1583, 1585, 1586, 1623—9 years	San Domingo.
1635	Guadeloupe.
1640	Guadeloupe, St. Croix.
1641	Martinique.
1642	San Domingo.
1643	Cadiz.
1645	Cadiz.
1647	Barbadoes, Cadiz.
1648	Guadeloupe, Martinique, St. Cristophe.
1649	Martinique.
1651	Martinique.
1652	Martinique, St. Cristophe.
1653	Guadeloupe, Martinique, St. Cristophe.
1655	Martinique.
1660	San Domingo.
1665	Barbadoes.
1669	Martinique.
1679	Vera Cruz, since 1679 and probably earlier, almost annually.
1682	Martinique.
1683	Martinique.
1684	Martinique, Pernambuco, Cadiz.
1685	Martinique, Pernambuco, San Domingo.
1686	Martinique, Pernambuco, San Domingo.
1687	Martinique, Pernambuco, Rio Janeiro, Bahia.
1688	Martinique, Pernambuco, Rio Janeiro, Bahia.
1689	Martinique, Pernambuco, Rio Janeiro, Bahia.
1690	Martinique, Pernambuco, Rio Janeiro, Bahia, Montserrat, San Domingo.
1691	Martinique, Barbadoes, Jamaica, San Domingo, St. Lucie.
1692	Martinique.
1693	Martinique, Barbadoes, Boston.
1694	Martinique, Barbadoes, Grenada, Rochefort.
1695	Martinique, Barbadoes, Philadelphia.
1696	Martinique, Barbadoes.
1697	Martinique.
1698	Martinique.
1699	Martinique, Barbadoes, Bermuda, Charleston, Philadelphia.
1700	Martinique, Charleston.
1701	Martinique, Barbadoes.
1702	Martinique, St. Thomas, Biloxi, New York.
1703	Martinique, Charleston.
1704	Martinique, Jamaica.
1705	Martinique, San Domingo, Cadiz, Mobile.
1706	Martinique, Antigua, Barbadoes, Niéves.
1707	Martinique.
1708	Martinique, San Domingo.
1713	Charleston.
1715	Barbadoes.
1720	Barbadoes, Martinique.
1721	Barbadoes, Martinique.
1722	Barbadoes, Martinique.
1723	Barbadoes, Martinique, Lisbon.
1724	Barbadoes, Martinique.
1725	Martinique.
1726	Martinique.
1727	Martinique.
1728	Martinique, Charleston.
1729	Martinique, Carthagena, Porto Bello, and St. Martha (South America).
1730	Martinique.
1731	Martinique, Cadiz.
1732	Martinique, Cadiz, Charleston, New York, Philadelphia.
1733	Martinique, Barbadoes, San Domingo, Cadiz.
1734	Martinique, San Domingo, Cadiz, Charleston.
1735	Martinique, San Domingo.
1736	San Domingo, Cadiz.
1737	San Domingo, Norfolk.
1738	San Domingo.
1739	San Domingo, Charleston.
1740	San Domingo, Barbadoes, Panama, Guayaquil.

TABLE No. 17.—*List of dates and places, &c.*—Continued.

Years.	Places.
1741	San Domingo, Carthagena (South America), Malaga, Charleston, Holliston, New York, Norfolk, Philadelphia.
1742	San Domingo, New York, Norfolk, Philadelphia.
1743	San Domingo, Catskill, New York, Philadelphia.
1744	San Domingo, Carthagena (South América), Cadis, Minorca.
1745	Charleston, New York, Philadelphia, Stamford.
1746	San Domingo, Cadiz, Albany.
1747	Minorca, New York, Norfolk, Philadelphia.
1748	Minorca, Charleston, New York, Philadelphia.
1749	Martinique.
1750	Martinique, Curaçoa, Jamaica.
1751	Martinique.
1752	Martinique.
1753	Martinique, Charleston.
1754	Martinique.
1755	Martinique, San Domingo, Charleston.
1759	Senegal.
1760	Curacoa.
1761	Havana, Charleston.
1762	Havana, Martinique, Charleston, New York, Philadelphia.

Analysis of the above historical records of the prevalence of yellow fever.

141 years, 1494 to 1635, there occurred 19 invasions during 16 of said years in 4 localities.
128 years, 1635 to 1762, there occurred 208 invasions during 86 of said years in 43 localities.

269 years, 1494 to 1762, there occurred 227 invasions during 102 of said years in 46 localities.

N. B.—As San Domingo was one of the 4, and also of the 43, localities, the sum total is 46 localities.

To these 227 invasions or epidemics should be added, certainly since 1679, the almost annual prevalence of the disease in Vera Cruz. It is believed that a thorough search into even the meager records in the histories of all nations would increase to more than 300 the above-recorded invasions, and yet the only list comparable to the above (M. de Jonnés) recorded only 83 invasions, 1494–1762.

It will be observed that there were in the United States 44 invasions recorded in twelve different places prior to the first invasion of Havana in 1761.

CHAPTER XIX.

HISTORICAL SKETCH OF THE RISE AND PROGRESS OF HAVANA AND CUBA IN CONNECTION WITH THE APPEARANCE AND PERSISTENCE OF YELLOW FEVER.

A glance at the chronological record of yellow fever in the Antilles, prior to 1762, demonstrates the fact, evident even at the present time, that some of these islands were frequently devastated, while others, though possessing the same climatic, geological, and other local conditions, were rarely, and some never, invaded. If the following facts aid to explain why Cuba was exempt until 1761, and has been annually invaded since then, it is confidently believed that historical research would disclose a similar series of facts in explanation of like exemptions and invasions of other islands of the Antilles. However, it is important to note that the long-continued exemption of some of these islands alone suffices to disprove the very common belief that yellow fever either originates spontaneously in all of them or holds them as lairs to lurk in until a white victim can be seized upon.

Spain took possession of Cuba in 1511, 19 years after San Domingo was taken possession of, 8 years prior to the settlement of Mexico, and 15 years prior to that of Peru. The gold mines of the three last attracted to them, to the neglect of Cuba, the military and commercial enterprises of Spain, so that "Cuba presented during two centuries and a half (1511-1761) a uniform aspect; the same plants were cultivated which had nourished the half-wild natives, and the vast savannas of the great island were peopled with numerous herds of cattle."—(P. 247, v. 3, Humboldt's Travels, Bohn's ed.)

Until the eighteenth century, says the same authority, Havana "exported only skins and leather," and not until after its capture by the English, in 1762, did it be-

come "the metropolis of the Antilles." Preyed upon by pirates and by hostile military expeditions, oppressed by Spain's most burdensome laws restricting colonial enterprise and commerce, Cuba made so little progress that in 1762, more than 250 years after its colonization, there were spread over the 47,000 square miles of this great island only about 120,000 people; for, in 1774, after 12 years of unparalleled prosperity, the first census enumerated a total population of only 171,620, of whom less than 100,000 were whites. In the hundred years succeeding 1762, this insignificant 120,000 had increased to nearly one and a half millions. An historian has well said, that for two centuries and a half Cuba remained in "a perfect state of lethargy."

Concerning this period, history records several facts of importance in reference to yellow fever. In early colonial times, fleets passing to and fro between Spain and America made the harbor of St. Domingo City their haven, while only subsequently did vessels from Spanish America delay at Havana to exchange gold for provisions, and to unite in convoys for their protection against corsairs and filibusters.

Even until 1765, Spanish colonial policy not only drove foreign ships from its provincial coasts by armed vessels or "guardia costas," but also forced its own vessels, loaded with provincial products, to restrict themselves to certain ports of the mother country. In early times this commerce was limited to Seville, some 50 miles inland, and north of the seaport of Cadiz. Buckle writes, "Seville, therefore, remained the only port for a long time, until the Guadalquivir, which, in the time of the Emperor Charles V [1516–'56] was navigable up to the town, became, for large vessels, inaccessible, when the port was removed to Cadiz, from whence, at stated times (usually once a year, in September), a fleet sailed for Mexico and galleons for Porto Bello." As is well known, Cadiz suffered earlier and more frequently during the seventeenth and eighteenth centuries with yellow fever than all other places in Spain, and this fact, while inexplicable by those who credit the spontaneous local origin of the disease, is by history readily explained as above to those who believe that yellow fever is portable.

Some facts will now be cited to explain why Cuba entered on a period of prosperity, thereby furnishing ample unacclimated material for the yellow-fever poison introduced in 1761, and ample opportunities both for new importations and for constant and extensive exportations of the poison.

The Spanish historian, Pezuela, in accord with all other authorities, writes: "An event which was apparently a misfortune, the capture of Havana by the English, awakened the public mind. The city was evacuated by them July 6, 1763, and from that time we trace the first efforts of a new-born industry." During the time of English occupation "new life was given to agriculture in Cuba by Engand's commercial activity and by the desire to open a new mart for her African slave trade." Without commerce or agriculture, "occupied chiefly in raising cattle" and "in smuggling," Cuba required so few African slaves that though these were first introduced in 1521, yet not more than 60,000 had been imported during the succeeding 240 years; while during the 60 years succeeding 1762, more than 400,000 were imported. As slave labor increased, so did the prosperity of Cuba increase with unfaltering step, until the disastrous insurrection of October, 1868, which, though officially terminated in February, 1878, continues to be a serious impediment to the renewal of prosperity in the east of Cuba.

Cuba's progress has been especially due to the culture of sugar, tobacco, and coffee, all the products of slave labor, and all cultivated to so little extent until after 1762 that they did not become of great commercial importance to foreign nations until the close of the eighteenth century. With slaves and increasing prosperity came thousands of immigrants from Spain and adventurers from every land, Spanish colonists from Florida (ceded to Great Britain in 1763), and many French colonists flying from the revolution, 1790–1794, in San Domingo.

While the rapid and enormous increase since 1762 in the population of Cuba, as shown in Chapter XXV in the statistics of its various censuses, is the most important proof of its rise and progress, yet the following proofs are also of interest. From 1763 to 1778 the cultivation of sugar was trebled; in 1764 the whole island did not export 2,000,000 pounds, while in 1815 it exported 85,644,400 pounds. "In 1764 the cultivation of coffee was not yet known; in 1815, from the port of Havana alone, after the home demand had been supplied, 918,263 arrobas [25 pounds each] were exported, at the rate of $6 to $7 each arroba." Cuba was of so little consequence even in 1789—twenty-seven years after the dawn of its prosperity—that the annual revenue derived from it by the government was only $700,000; this had increased in 1824 to $5,000,000, in 1852 to $16,000,000, and is reported to have been in the financial year 1878–'79, with a population less than a million and a half, $57,838,552.28. But slave labor and its products could never have yielded such remarkable results if Spain had not relieved Cuba and other colonies from some of the intolerable commercial restrictions imposed upon them. The following extracts from Buckle's History of Civilization (pp. 93–95, vol. 2, Am. ed.) will throw some light on this subject:

"It was also in the reign of Charles III [1759–1788] that the American colonies were,

for the first time, treated according to the maxims of a wise and liberal policy." "Towards this end, and with the object of giving fair play to the growth of their wealth, he did everything which the knowledge and resources of that age allowed him to do. In 1764 he accomplished what was then considered the great feat of establishing every month a regular communication with America, in order that the reforms which he projected might be more easily introduced and the grievances of the colonies attended to." This monthly communication was more especially between Cadiz and Havana. "In the very next year, October 16, 1765, free trade was conceded to the West Indies, whose abundant commodities were now, for the first time, allowed to circulate to their own benefit, as well as to the benefit of their neighbors. Into the colonies generally vast improvements were introduced, many oppressions were removed, the tyranny of officials was checked, and the burdens of the people were lightened." "Early in the reign of Charles III steps had been taken towards the adoption of more liberal principles in the commerce with America, but in the year 1778 a complete and radical change was introduced. The establishment of a free trade rapidly produced the most beneficial consequences. The export of foreign goods was tripled, of home produce quintupled, and the returns from America augmented in the astonishing proportion of nine to one. The produce of the customs increased with equal rapidity."

The modern reader is apt to be very much misled by the expression "free trade" in these extracts, an expression used in so relative and restricted a sense, that history declares repeatedly in various years subsequent to 1765 that Spain had granted free trade to Cuba. But, in truth, at no period whatever, certainly not in 1879, has Cuba ever enjoyed that which modern political economists understand by "free trade." Apparently the free trade which Buckle refers to, as granted in 1765, was solely that then Spain first "removed the restrictions which confined the colonies in the ports of Spain to Cadiz and Seville alone." However, Pezuela, while referring to concessions granted Cuba in 1765, so important that marked prosperity followed at once, states that it was in 1778 that occurred "probably the most useful of all the proclamations issued by the government, viz, the declaration of the liberty of commerce between the chief ports of Spain and of America," *i. e.*, of Spanish colonies in America. As additional evidences of the limited significance of free trade as applied to the policy of Spain, and of the causes which had so long kept Cuba in a state of lethargy, the following facts are cited:

Only "in 1771 was Havana, as well as other Cuban ports declared open to the commerce of the world in certain articles of grain, &c., used as provisions." "In 1792 coffee, indigo, and cotton were declared exempt from tithes for 10 years; in 1804 this exemption was made perpetual, and was extended to sugar plantations then in existence." "In 1815 the restrictions on and the government monopoly of tobacco were removed, the trade opened to the public, and from that time, it may be said, commenced the cigar business, and its growth to be the second business in extent in the island." "The right to enjoy commercial intercourse with other nations besides the mother-country was granted on February 10, 1818."

The historical facts now cited will suffice, it is believed, to aid us in understanding why Cuba did not become until 1761 a favored resort of yellow fever.

But there is another point worthy of consideration in the present connection; this is, that since 1761 there has been a greater and greater dissemination of the poison throughout the island. This extensive dissemination was especially marked during the insurrection, 1868–'78, when, in some of these years, Spain traversed every part of the island, and especially the eastern department, with 100,000 soldiers. None the less, country towns and villages did in former times generally escape the disease, and not infrequently some still do. It is confidently believed that one of the causes of this consists in the varying facilities of travel, and that this point deserves brief consideration.

Since early times the ordinary roads have, of course, been improved. But, referring to these in recent years, one author (Thrasher) states: "We may observe generally that in the western department they are fair, in the central poor, and in the eastern impracticable for wheel carriages. The common roads are little more than open portions of country left for public transit, and being without grading or repair of any kind upon them, partake of the qualities of the land where they may be located. In some places they are hilly, stony, and dangerous, in others they have a deep alluvial soil, intransitable except in the dry season. Traveling is, therefore, a matter of no little trouble and delay." Another author (Hazard) reports: "Without the assistance of railroad and steamboat routes, the communications on the island of Cuba would be the worst in the world. The nature of the earth, and the abundance of the rains, which produce frequent inundations, and almost perpetual mud, in which horses and conveyances get stuck fast, do not permit of the construction of other roads than the expensive calzadas [or public highways]. Of these there are many." "On all such roads journeys can be made in the volante, but the moment these principal roads are left, it becomes a matter of imperative necessity to go on horseback, as, by other means, travel would be impossible."

These extracts give sufficient information of the difficulties of inland communica-

tion in Cuba, difficulties which extended to every part of the island until November, 1837, when the first railroad to Cuba was opened to travel, over the 17 miles from Havana to Bejucal. By 1852 Cuba had 360 miles of railroad, 300 of these concentrating at Havana, and Pezuela reports (p. 359, v. 2) that in 1860 there were 794 miles. Comparatively little has been done since 1860, so that in 1873 only 829 miles were reported as completed. The inland points most distantly connected are Paso Real, about 25 miles east of Pinar del Rio, and Villa Clara, and these places are about 300 miles distant. From this route diverge a number of roads, chiefly to northern but some to southern ports. In addition, there are a few short roads in the east.

It is noteworthy that throughout Cuba, railroad cars have cane or wooden seats, wooden lattice windows, and are entirely destitute of upholstery of any kind, ever of a window curtain.

CHAPTER XX.

QUARANTINE LAW OF SPAIN.

The following memorandum was kindly furnished in September, 1879, by Dr. Pardiñas, medical director of military hospitals at Havana:

"The law now enforced is the royal decree of April 17, 1867.

"1. A clean bill of health, complying with all legal requirements, exempts a vessel from quarantine, provided that it be officially stated that no contagious disease prevailed at the port of departure; that the vessel has had no suspicious cases during the voyage; that the vessel, when inspected, is in good hygienic condition; and that on arrival it is subjected to an official visit and inspection.

"2. Vessels from Egyptian, Syrian, or any ports of the Ottoman Empire are not admitted, since said ports have no sanitary service, to 'free pratique,' even though having clean bills of health. Such vessels are required to pass 8 days at sea, if they have a medical attendant on board, and if they have no such attendant, 10 days.

"3. Vessels from the Antilles, Mexico, Guiana, and South America are quarantined from May 1 to September 30. Even if they have clean bills of health they are kept in quarantine 7 days, the days being counted for persons from the day these enter the lazaretto, and for vessels from the day their cargo is discharged. But if vessels having clean bills of health present a bad hygienic condition, giving cause for suspicion, such vessels may be subjected to all the rigors prescribed for vessels with unclean bills of health.

"However, this law has recently been considerably modified. For, during this present season of 1879, the mail steamers from Havana to Santander, on the north coast of Spain, have been subjected to only three days' quarantine for baggage, while passengers have been permitted to land immediately on arrival."

It is regretted that no more information than is above stated has been collected respecting the history and character of the protective measures adopted by Spain; a subject of great interest, in connection with the facts that during centuries Spain has held close commercial intercourse with constantly infected centers; that it has been from the earliest times frequently devastated; that this devastation was widespread and unprecedented from 1800 to 1829, and that since that time Spain has suffered comparatively little.

Spain adopted a law, quarantining the ports of the Antilles and Gulf of Mexico from May to September 30, certainly as early as 1855.

CHAPTER XXI.

NOTES ON THE PREVALENCE OF DENGUE, CHOLERA, LEPROSY, BERIBERI, AND THE HORSE EPIZOÖTIC IN CUBA.

DENGUE, OR "CALENTURA ROJA."

This disease was first observed in Havana in March, 1828, and prevailed throughout the whole island. It also prevailed as an epidemic from 1865 to 1867. No records were found of its prevalence subsequently. (Anales, pp. 322, 435, 440, vol. 8, 1871.)

ASIATIC CHOLERA.

Cholera first appeared in Havana on February 24, 1833, and prevailed until 1836. Its second visitation was from 1850 to 1856, and its third and last visitation was from 1867 to 1871.

Various reporters of the first importation call attention to the remarkably insanitary condition of the city, and to the reckless disregard of sanitary laws; and also state that during its greatest intensity the weather was most excellent, the sky limpid, the breezes delicious, and the temperature extremely agreeable.

LEPROSY.

This disease, common among negroes, has long prevailed in all the Antilles. So early after their settlement did it prevail that from 1694 to 1713 the little island of Tortuga was set apart as a refuge for lepers expelled from others of the Antilles.

In Cuba there are now, as is reported, two, perhaps three, hospitals (one at Havana, one at Villa Clara, and one perhaps at Puerto Principe) for lepers, who are reported to be most numerous in the central and eastern parts of the island. The San Lazarus Hospital, in Havana, was founded by a wealthy leper. It has an annual revenue of $35,000, and is an admirable institution. The first admission was in 1784, and to September 19, 1879, the total number admitted had been 1,014. On said date there were about 95 inmates, some 50 Chinese, many negroes, a few Cubans, and only one European, a Spaniard. Of the 1,014 admissions only one is recorded as "discharged cured." Several of the patients, present on the day of inspection, were born and had always resided in Havana; there were some boys under 20 years of age, but Drs. Rodriguez and Burgess both testified they had never seen a case under 12 years of age.

Dr. Rodriguez had never heard of a case originating in the hospital. An extremely intelligent and affable sister of charity testified that there were more than 20 non-leprous employés who lived in the hospital; that these washed for the lepers, cleaned their rooms, chamber-pots, &c., and in every possible way came in daily contact with them; and yet, that she, who had had 29 years' experience in this hospital, having lived in it during the past 13 years, had never seen nor heard of any case originating in the hospital.

Every variety of the disease presented itself, elephantine feet and legs, leonine visages, mutilated and destroyed toes and fingers, even hands and feet. Popular prejudice in Cuba attributes the disease to a pork diet.

BERIBERI.

This tropical disease, well known in the eastern hemisphere, and reported to be the most fatal disease, next to cholera, in Ceylon, was, according to Professor Gallardo, M. D., of Havana, imported into Cuba by the Chinese coolies, having been observed for the first time in June, 1847, the date when the Chinese were first imported. Drs. Anguita and Vega, appointed to report upon this disease, finally concluded that it was imported. Apparently it was not observed outside of the Chinese until May, 1853, and not generally recognized until 1859. When at last contradistinguished from other diseases with which it had been confounded, it was found to be committing great ravages in the localities where the Chinese most abounded, as in the extreme western province of Pinar del Rio. Coolies had been employed especially in this province because of the scarcity of negro laborers. As the eastern and central departments obtained abundance of negroes from slave ships the Chinese coolies passed slowly eastward, and beriberi followed their footsteps. Especially affecting the Chinese and the negroes, it has been a disease of plantations and of sugar houses; however, the whites are not entirely exempt.

Professor Gallardo considers beriberi an imported and communicable disease, and that the conditions which favor its development are tropical heat, humidity, insufficiency and too great sameness of diet, and bad hygienic conditions. He attributes the much greater susceptibility of the Chinese and negroes to the fact that their diet and hygienic conditions are worse than those of the whites. He discredits the views of many physicians who find the causation of the disease in some dietetic abuse, such as the constant use of rice, the habitual drinking of honey or molasses with water, &c.

In 1865 Dr. Dumont reported the prevalence of the disease in the province of Matanzas, and published some incomplete statistics, which would indicate that during this season there were some 110 cases, with about 37 deaths, among 1,150 Chinese and negro laborers on four plantations.

In 1871 Dr. Grima reported that the disease was epidemic in June, July, August, and September and caused many deaths on some plantations in the jurisdiction of Matanzas. He found no obvious cause for the disease, and asserts that it certainly was not due to lack of abundance of good food, water, and air, nor to excessive work. Anemia, œdema, numbness of the surface generally, and paralysis of the lower extremities seem to be the most characteristic symptoms.

Aitken, referring to the disease in Ceylon, says the two most prominent phenomena in the etiology of the disease are its limited geographical range and the length of residence in an infected locality necessary to develop it. Several months' residence,

eight to twelve, in a beriberi district are required. Europeans are much less liable than the natives, but when attacked the disease is more fatal. [See Anales, vols. 2 (1866) and 8 (1871), and vol. 2 (1876) Cronica Med. Quir. de la Habana.]

HORSE EPIZOOTIC.

This disease prevailed in Cuba, and especially in Havana, in 1872. Coughing and catarrhal symptoms especially characterized the disease; other symptoms were anorexia, drooping head and ears, occasional swelling of the submaxillary glands, and a nasal flux on the second or third day, which assumed a greenish color on the fifth or sixth day. Some few deaths occurred, but these were due to complications.

This disease was universally believed to have been an infectious exotic disease imported from the United States, where the disease did exist, and from whence are exported many horses to Cuba. It occurred first and was most severe among these imported horses, subsequently attacking Cuban horses, but was in these apparently, milder, yet obstinate. (Anales, vol. 9, 1872.)

CHAPTER XXII.

ARTIFICIAL CANALS AND OTHER MEASURES REQUISITE TO RECTIFY THE INSANITARY CONDITIONS OF THE HARBOR OF HAVANA, BY COL. ALBEAR, CIVIL ENGINEER.

["Real Academia de Ciencias Medicas, Fisicas, y Naturales de la Habana, Cuba. Ordinary public session, September 28, 1879." Report on the project of a drainage canal for the city of Havana, by the meritorious member, Don Francisco de Albear y Lara; and approved by the Academy.]

MR. PRESIDENT AND FELLOW ACADEMICIANS:

I. The administrator, Dr. Don José de Argumosa, presented to the honorable council of this capital on the 15th of November, 1878, the following motion:

"HON. SIR: I propose to your excellency the execution of the grandest work that has ever been accomplished by any council. The public health is interested in it, and it is bound up with the future of the island, and with the existence of this city, over whose interests we ought to watch. Two grave problems will be solved satisfactorily, if the work I propose is accomplished: a considerable dimunition in yellow fever, and, it may be, its extinction as an epidemic in Havana, and the preservation of the harbor, which is now advancing, by gigantic strides, towards filling up. If we succeed in destroying in their cradle the causes of yellow fever, commerce will increase, because the white immigration will be greater, and we shall have solved, in the best possible manner, the social and economical question of the island of Cuba, and of its agricultural products. We shall deserve the thanks of mankind, because it will not be easy to repeat calamities like those that have afflicted Cadiz, Barcelona, and so many other cities; all of which were owing to ships proceeding from Havana. All the doctors, who have practiced here a few years, agree, in sustaining the opinion, that from the emanations of the putrid waters of the harbor proceeds the deleterious cause of yellow fever.* The harbor is the great cess-pool of the city, of all the suburban villages which surround it, and of the large population living upon the water. The harbor, into which flows all the garbage, not only of the people, but also of the animals killed in the slaughter-houses, is a great recipient of sediment, which is visibly diminishing the depth of, and will in the end close up, this precious harbor, the sole cause of the prosperity of the city. The fact that there is scarcely any ebb or flow of the tide in these latitudes gives us no hope of assistance from this source; and the plan of preserving, by means of dredging, what now remains of the harbor, will, besides being very difficult, gravely affect the public health; because of the great frequency, and of the grand scale of the dredging which would be necessary, whereby we should be incessantly stirring up a great mass of decomposing organic matter. This danger, without doubt, would be certainly warded off by the accomplishment of the work I propose. In order to avoid the future ruin of this city, emporium of the commerce of the Antilles, to ameliorate greatly its hygienic conditions, and to lessen if not to abolish yellow fever, there is one great remedy, the only wise and durable one, which consists in opening a wide and deep canal from the Christiana Bridge, or, better still, from the mouth of the ditch of the slaughter-house, passing to the east of the intersection of the Infanta avenue and the Tacon drive, and terminating at the creek of San Lazarus. This canal, establishing direct communication between the bottom of the harbor and the sea, will establish a constant current of the waters, with-

*The reader will find that the facts recorded in Chapter IX refute this view.—S. E. CHAILLÉ.

out causing them to be full of sediment, at least only partly full of earth and garbage gathered from ditches and sewers. It is true, that the intertropical currents have not here the strength nor the constancy of those on the coast of the rest of the Antilles; but there is always, on our coast, enough motion of the liquid mass, first on one side and then on the other, to prevent the harbor, having an issue through the canal, from filling up within a short time. This work, which appears to be gigantic and very costly, might not turn out to be so for the honorable council, but might perhaps prove even productive. The grounds through which the canal would pass, divided into lots, in which dwellings and warehouses would be built, and where the lighters and other craft would come, would naturally increase their value, and enterprising parties would no doubt be found who, to enhance the value of lots, acquired at low prices on forcible expropriation according to law, would undertake to make all these improvements, and the city would find its taxable property increased by that much. To fulfill its purposes, the canal ought to be at least 12 meters broad and from 8 to 10 deep, and its sides or banks must be lined with stone for the two kilometers from the harbor to the Tacon drive. This stone can be obtained in abundance from the other kilometre, reaching from the Tacon drive to the San Lazarus Creek, its subsoil being stone, and consequently this portion will not require any walling in. As supplementary work, it will be necessary afterwards to terrace those portions of the shores of the harbor where it is of little depth, and where consequently the fermentations are most active, as in the coves of Atarés and of Guasabacoa. This will, besides contributing to the sanitation of the city, produce, from the gains of the swamp lands, great advantages to the State and municipality. In consequence of all that I have explained, I beg the honorable council to approve of this motion, and I solicit for it a kind reception by the Governor-General of the island, in order that, after having been studied, and discussed by scientific societies, they may decide if it be simply the expression of a sterile good will, or if it contain a project as useful and as grand as I consider it; and, in case of thus judging it, let it be submitted to those whom it may concern, in order that its technical and economical points of view, having been ascertained, contracts may be made for letting out the works at public auction.

"Havana, November 15, 1878.

"JOSÉ DE ARGUMOSA."

Taking into consideration this proposal, the honorable council agreed to refer it to the Governor-General, who in turn referred it to various departments of the state, who reported as follows:

The general inspector of public works reported: "In case this measure be approved by the societies called upon to examine the project, an engineer should be appointed to draw up the plan of the work according to existing regulations." The War Department, in conformity with the opinion of the general commandant, inspector of engineers reported "that there is no inconvenience in studying the plan of this canal, but that to the engineer charged with this study there must be added another officer to consider the interest of the fortifications in connection with the other interests to be served by the project." The Naval Department at this station reported that "it will be no inconvenience to this office to undertake the studies necessary to effect the opening of the canal."

With these reports, the plans were returned to the honorable council, which in its session on the 14th May, 1879, seeing, without doubt, that none of the reports touched on the fundamental question whether the proposal was in effect useful and practicable, agreed to place the project before this academy for discussion, which has been done by the civil government of this province.

The commission appointed to study this project now publishes its opinion, which it submits for the information and approval of the academy.

II. The enthusiasm with which Don Argumosa has welcomed the idea and proposed the execution of this canal is worthy of the highest praise. Unfortunately, it is not as common as it should be to see the efforts of our public men stripped of all personal interest, and devoted exclusively to the good of the country. We said "welcome," because the idea of the proposed canal is already old; it suggested itself at the end of the last century to one of our military engineers, not so much as a means for ameliorating the public health, but as a means of defense for this city. In chapter 1 of the political essay on the island of Cuba, by Baron Humboldt, written at the commencement of this century, we read the following: "The inhabitants of the suburbs have presented many projects to the King, by which they might be included in the line of fortifications of Havana. It was proposed to make a wide ditch from the Chavez Bridge, near the slaughter-house, as far as San Lazarus, which would result in making Havana an island. The distance is something less than 1,200 toises [or 2,560 yards], and already the harbor terminates, between the arsenal and Fort Atares, in a natural canal, whose shores are covered with mangroves and cocollobas. In this manner the city will have, towards the west on the land side, a triple file of fortifications, first the forts of Atares and of Principe, for the outside, placed on eminences;

then the projected ditch, and finally the wall and the old covered road of the Conde de Santa Clara."

In our day this work is not looked upon as a means of defense for the city; for this purpose it would be of little or no use, and probably would be prejudicial as an obstacle to the movement of the active means of defense; it has to be considered solely as a civil work, under the triple aspect of the practicability and cost of execution, the advantages to the city and to the harbor, and the influence on public hygiene. Let us treat these three points separately. But before entering on the examination of the enterprise which occupies us, it is proper to point out some dates, facts, and information bearing on its importance and magnitude.

We do not now propose to investigate what are the means to be used to correct the evils and injuries we have done to the once magnificent harbor of Havana, and which have come back to us in various ways to our own great disadvantage. For many years we have been interesting ourselves in measures to improve Havana, and many are the essays, memoranda, and projects displayed and works undertaken with this end in view. Let us take a short review of these:

"From the beginning of the past century," says Don José Maria de la Torre in his Ancient and Modern Havana, "there have been boats for dredging the harbor. In the time of the Marquis de la Torre (from 1771 to 1777) there were established six pontons or boats and six lighters; in 1773 four more boats were constructed; in 1833 a steamboat was added, and this has since been replaced by others." The same author quotes the interesting "Essay on the Preservation of the Harbor of Havana" published in Santiago de Cuba in 1852 by its author, Don José Gomez Colon, and recommended another essay on the same subject by Don José de Arazoza published in 1816.

During the last twenty-five years of its existence the royal junta, for the promotion of the agriculture and commerce of this island, presented, or there issued from this corporation, some interesting works, and its solicitude for the cleaning of the harbor was notorious. From that time dates the establishment of a dredge-boat, which has been almost constantly at work producing good results although very inadequate to those necessary.

Besides the canal on the west, from Taillapiedra to San Lazarus, with which we are just now occupied, another has been proposed on the east side of the harbor, from the Triscornia Creek to the sea, passing between the forts of Cabañas and of No. 4, with the object of using the lateral current of the gulf for the cleansing of the harbor. The execution of this idea will not lead, as we can easily demonstrate, to any practical results favorable to our harbor.

A third canal has also been spoken of recently, but in such an indefinite manner that it is not possible to even form a correct idea of what is proposed. "A canal," they say, "in the island of Cuba which must be cut in such manner as to give free access to the waters of the Gulf, so that these may enter into the harbor of Havana and cleanse out the bottom of the harbor." It is added that "the canal is of great importance, and that if the sea could regularly wash out the harbor of Havana, this city would be freed from yellow fever." It is not possible to take into consideration an idea expressed in such a vague and confused manner. The execution of this idea is impossible; it would give results opposed to those desired to be obtained, and would be a miserable imitation of water-works, by means of locks and sweeping currents, used in many artificial harbors, with a narrow entrance, at places where the tides are high; but such works are inapplicable to the harbor of Havana.

It has also been proposed to introduce the river Almendares into the harbor, with the object of using its current to wash out of the harbor the sediment at the bottom. Leaving the ground free to our associate, Señor Paradela, who proposes, with good data and with his usual ability, to examine leisurely this and the other ideas brought forward, we will only say that having to do with a river whose volume does not ordinarily exceed 4 to 5 cubic meters a second, we can place the Almendares in the same class, as to the effects of its current in the harbor, as the rivers Luyano and Martin Perez, with which we will later occupy ourselves.

One of the happiest ideas, with this end in view and to prevent the future filling up of the harbor, was the idea presented by Don Erminio Leyva, who proposed to make a railroad from Regla to Taillapiedra on the shore of the harbor, filling up the marshy places on the land side, and without excavating the lower places on the water side. This idea appears practicable to us, and is at least worthy of consideration; but it is limited to only one part of the harbor, and even for this it is nothing more than one measure, susceptible of improvement, among other measures which ought to be considered for the general reform of the city and of its harbor.

Many and excellent are the plans we have of the harbor of Havana; the majority of them were made with the object of studying the progress of the filling up of the bottom, and the means of preventing it. Among these, that of Col. D. Juan Alvarez de Sotomayor, made about eighteen years ago, deserves to be mentioned.

In 1871 a proposition, and in our estimation a most advantageous one, to cleanse the harbor was offered; with this object in view the supreme government ordered an

official report of it to be made. This was done with admirable clearness and exactness by our fellow-academician, Señor Paradela. He submitted his report to the government in 1874, and happening to suggest that a meter should be added to the depths proposed by Señor Paradela, this project or plan went back through the same circle of proceedings, and was only passed as approved five or six months ago. According to this plan for clearing the harbor, the total volume of sediment to be carried off mounts up to nearly 12,500,000 cubic meters, and its cost to about $4,750,000; it estimates that to do the cleansing it will take twenty years, and need three trains for excavation and transportation.

Let us also recall numerous and excellent works presented to this academy by some of its members, which refer directly or indirectly to the bad condition of the harbor. Among them we note some by our celebrated hygienist, Dr. Ambrosio Gonzales del Valle; some by our corresponding member, Mr. Dumont; some by the Most Honorable Dr. José de la Luz Hernandez; some by the distinguished Dr. Luis McCowley; and the extended and searching essay of our illustrious member, the engineer Don Manuel Montejo.

These and many other works in which the government has for a long time taken a great interest, as well as the naval department, the royal junta of agricultural protection, our academy and other societies, and many individuals, show sufficient knowledge of the existence of the evil, its magnitude, its fearful increase, and the urgency of a remedy. They show that we do not need any foreign stimulus to make us understand fully our miserable and unhappy condition as to many points of interest in public hygiene, and especially the lamentable condition of our harbor. We may have needed the things required to apply the proper remedy, but not the want of knowledge of the evil, nor the great desire to extirpate it. All these ideas, these plans, and these works deserve consideration and respect, because they treat of the life of Havana. They are the expressions, more or less vehement, of an imperious necessity; they are the unanimous clamor of a city that feels itself at death's door.

When we say that they treat of the life of Havana, we exaggerate nothing. So much has been said, written, and published on our sad hygienic condition because of the state of our harbor, that it would be taxing unnecessarily your kind attention if we recapitulated here the multitude of facts which come forcibly and in rapid succession to our minds, crowding themselves there, each one bringing its hard and frightful proof of the sad truth. We will only allow ourselves to indicate some of the principal features which will lead directly to the report now under consideration.

III.—The basin of Havana, or the ground drained by the waters that empty into the harbor, is not very extensive—about 5,600 hectares (13,832 acres), including the harbor; and without this and its marshes you can calculate it at 4,800 hectares (11,856 acres), of which the population occupies the sixth part. Taking, for all this extent, as the annual mean quantity of rain water 1,390 millimeters (53 inches) (which is the annual average of Havana for the five years from 1865–'69, according to Dr. Gonzales del Valle) we will have about 67,000,000 of cubic meters of rain-fall in each year; of which quantity only a part can reach the harbor.

It is difficult, however much it may be desired, to calculate with any exactitude the distribution of the rain-fall, because, besides that which flows on the surface, evaporation, infiltration, absorption by the ground, and the necessities of animal and vegetable life consume very considerable quantities, which vary between very extended limits, according to climates, situations, geological formations, and topographical conditions. Much time, labor, and experience have been necessary to bring together, in different countries, the multitude of diverse experiments and valuable analyses which have given, as results, data sufficiently approximative to determine, with some precision, the laws of the rain-fall water, a study on whose importance it is superfluous to dwell. For us it is much more difficult, because we lack direct experiments in our particular case, experiments which in some measure would determine the distribution of our rain-fall, and hence we can only proceed by inductions more or less approximative, and by comparisons with observations taken in other localities. But this comparison is not enough, as we shall see.

In England, for example, the quantity of rain which penetrates the earth to almost a meter in depth, is, in the red sandy soil of Manchester, according to Dalton, whose observations lasted three years, about 25 per cent. of the total rain-fall; according to Charnock, from the results of five years' experiments in the chalky magnesia soil of Fernbridge, it is only 19 per cent.; Dickinson, who for eight years watched the penetration of the rain in the sandy marl which covers the valley of Walford, calculates as high as 43 per cent., while Stephenson, on the same ground, thinks that it is 44.8 per cent.; Prestwick calculates it for the tertiary and chalky soil of London, from 36 to 60 per cent. Other English observers say that, on land less absorbing than the sandy marl, they calculate that one-third of the whole rain-fall evaporates or is used up in the nutrition of plants; another third runs into the rivers and brooks, while the remaining third sinks into the ground. The same variations are to be found in Spain, France, Italy, and the United States. The same quantity is consumed by evaporation

and by animal and vegetable life, and so we can prove the quantities consumed by all the causes together.

From the multitude of reports given in his excellent work by Mr. Beardmore, we may conclude that the proportion between the water running into the rivers and brooks, and that lost by evaporation, infiltration, vegetation, &c., varies from one-third to four-fifths. Mr. Hawkesley gives as a mean average 43 per cent.; Mr. Stirrat, after three years of experiments at Paisley, 67 per cent. In Madison County, New York, some very delicate experiments have been made, which have placed this proportion at 66 and 50 per cent., and in Albany it has varied from 33.6 to 82.6 per cent. The great American engineer, General Gillmore, in his plan to ameliorate the channel entrance into Charleston, calculated that one-half the rainfall would find its way into that harbor. A multitude of reports in France will show the same variations; we will only quote Jarey, who declares that only one-half the rainfall can be relied on for the formation of artificial fountains. Bobine, in his article, "The Watering of the Globe," and Freycinet, in his valuable work on the "Sanitation of Cities," are of the same opinion.

But why tire ourselves in going over the numerous reports made in other countries if the problems they solve are exclusively geographical, sectional, and even of small and circumscribed localities? There are, without doubt, some points of comparison between those we have selected as having most analogy with our particular case, and these will help to an approximate solution of our case by means of the following considerations:

Abundance and continuity of rain.—The difference between ourselves and the countries named is seen at a glance, but as happens in them so we observe that the little showers of the dry season, and even the first of the rainy season, are entirely used up by evaporation and infiltration. We ought not really to count on for our purpose any other time than that when the rainy season has well begun and when there is a superfluity of water to run over the surface of the earth and so reach the harbor, in addition to the usual quantity which the rivers and brooks empty into it.

Evaporation and vegetable absorption.—The results of the experiments made in our offices and observatories are well known as to the quantity of water evaporated, but this is not enough for our object. More than 3,500 hectares [8,645 acres] of the basin of Havana are covered with vegetation, generally poor and scrubby. In the places destitute of trees, places which are very numerous in our basin, the evaporation is much greater than elsewhere—a fact agreeing with general observations and with those presented at the last Paris Exposition by Messrs. Mathieu and Fautrat, who demonstrated that in open ground the evaporation is three times as great as in forest land. The great amount of water sucked up by plants in our country is well known, but supposing that it were only 6,000 cubic meters to every hectare, the quantity taken up by plants in one year—a quantity that does not vary much from the observations of Saussure and Hales—we would here have consumed on the 3,500 hectares 24,000,000 of cubic meters, or more than the third part of the rainfall, without counting any loss by evaporation. Stephenson and other English engineers and physicists calculate, as we have already seen, on one-third of the rainfall being consumed by vegetable life and evaporation.

Permeability of the soil and slopes of the lands.—Those circumstances which influence principally the solution we seek relate, in the first place, to the penetration of water and to the system of rivers; and, in the second place, to the velocity of the currents and their strength. Thus, in the porous lands, such as the limestones and sandstones, the rise of the rivers is small and the waters but little muddy, while in the impermeable soils, those of clay or rocky formation, the rise is great, of short duration, and full of débris. But when the slope is very great it gives the current an additional force, so violent at times that even in porous lands the rivers become impetuous torrents, which sweep off and drag away any loose material they may meet on their way. Now, if both these causes are wanting, or if both causes occur at the same time to produce the currents, the effects are extraordinarily distinct. France presents a notable example of this difference and of these influences. The Somme, which flows with some slight inclination through porous lands, does not rise more than one-third, at the most, higher than its usual level, while the Loire, which runs over a soil almost impermeable, and has its source in high lands and receives its upper affluents from very steep slopes, swells at its rise to 400 times its ordinary volume, or, relatively, 100 times more than the Somme.

Without going into a geographical or topographical description of the basin of Havana, a task now in the hands of the learned and talented inspector of mines, Don Pedro Salterain, we will state on this point what is necessary for our discussion, following partly Señor Cia's authority.

The dividing watershed which encircles the basin of Havana, on which are situated the three forts, Morro, Cabañas, and No. 4, begins on the tops of the limestone hills. In all this extent to the north of the harbor it keeps but little distance from the shore. It follows the same direction towards the east, but leaves the shore more

and more, until it reaches the south of Guanabacoa, and about a kilometer and a half [nearly one mile] from the harbor it bends towards the north, leaving at its left the valley of Cojimar. Already, before reaching this point of change of direction, as soon as the level of Fort No. 4 is passed the soil begins to be more clayey, varying from almost pure limestone to regular clay banks. There crop up afterwards, in Regla, Guanabacoa, and the intermediate neighborhood, serpentine rocks. Towards the south this is followed by the ophitic hills, which continue around the harbor. The divide, continuing towards the south, leaves the harbor more and more, until it reaches a kilometer [three-fifths of a mile] beyond San Miguel, where it encircles the valley (5 kilometers, or 3 miles, wide) of the river Guanabacoa. Here the divide is, on its lower side, made up of mixed formations of tertiary lime rocks, and of serpentine, like those of Regla and of Guanabacoa, while the rest of the valley is of lime banks and of clay deposits, with some marl. These same formations make the basin of the river Luyano, which traverses in its course a little more than 4 kilometers. The divide, after closing up toward the south of the valley of the Guanabacoa and of the Luyano, sweeps towards the northeast from the hills of Calvario, passing by those of Jesus del Monte, Incela, and Palatino, which give birth to the glens of the Valiente and of the Aqua Dulce Creeks, which empty into the cove of Atares after running about 3 kilometers through ground abounding in chalk and clay deposits. Finally it changes towards the north, passing the marl hills of El Cerro, those of the Jesuits, and of Arastegui, keeping about 3 kilometers from the harbor, until, turning towards the east at the last bridge built by Charles III, it goes on and terminates at the fort of the Punta, surrounding the chalky plain on which are built this last fort and the city.

In general, the soil seems of tertiary chalky formations, rising to the west by a cropping out of the surpentine rocks without any stratification, and very flawy, whose transition is plain at some points and hidden at others by the marl, the débris, and the vegetable earths; so that at the southern extremity of the harbor, at Garcini, and at other points, the soil seems a quaternary formation. Thus it is seen that soils of all classes abound, porous and non-porous, although the first class predominates. But the culminating fact is the great slope of the land, favorable to the rapid running off of the water, diminishing the absorption and evaporation, and increasing the débris. The divide crosses the summits of the heights and hills at about 40 or 50 meters [131 to 164 feet] of elevation, which is only at one point as distant as 5 kilometers from the harbor, and is at a still less distance in the rest of its course; this causes the currents to become torrent-like during the heavy rains.

Noting all the local circumstances, and the facts observed in like regions, we will have much difficulty in making out 43 per cent. as the maximum quantity of rainfall which reaches the harbor by the rivers and the draining of the lands. If to the 28.8 millions of cubic meters, which is 43 per cent. of the 67,000,000 of rainfall in a year, we add the actual supply of all other water, the greater part of which goes to the harbor, we can establish approximately that there enter into the harbor, as an actual annual supply and as its maximum, 32,500,000 cubic meters of water. This quantity of water, almost equal to what is contained in the harbor from the mouth at the Morro, produces débris and sediment enough to explain the condition of our harbor. From the many calculations we have before us, as to the quantity of matter held in solution in running water, we will use some which we believe we can rely on. Captain Calver, in his last official reports, calculates 100 grains of matter to the imperial gallon in the turbid waters which empty into the Thames; this is equal to 1,429 milligrams to the liter. Professor Williamson says 151¼ grains to the gallon, which makes the proportion 2,165 milligrams to the liter. Messrs. Humphreys and Abbot, not contradicted by Eads, say that as much as 650 grains of matter to the cubic foot are held in suspension in the high waters of the Mississippi, which amounts to 1,471 milligrams to the liter. In the canal which carries the waters of the Durance to Marseilles the proportion at the muddy season is as high as 4 grams to the liter. From various experiments which we have had made on the waters of the Luyano, the Almendares, and the Zanja, when swollen by the rain, we find that the quantity of material held in solution varies from 1,000 to 6,350 milligrams to the liter. Notwithstanding this, taking 2,300 as an average mean, which is nearer to the average results of the greater number of experiments, we can safely say that the quantity of deposit taken to the harbor by the rain is 74,750 cubic meters a year. To this quantity we must add the products of sewers and of the washings of streets, which empty directly into the harbor. The tables published by Professor Way, the results of his analyses of surface water in the rainy season in the principal streets of London, which he classifies according to pavement and amount of traffic, demonstrate that the washings of the most traveled macadamized streets, and even of those curbed with granite, carry in solution as much matter as that from the dirtiest sewers. In Oxford street, for example, on the macadamized portion, the water carries 8,358 milligrams, and on the granite-curbed portion 11,622 milligrams to the liter, the one-third part in both cases of dissolved matter and the other two-thirds being of matter held in suspension. We believe

hat for that part of Havana which drains into the harbor, and for Regla, from which nnually flow about 7,000,000 cubic meters of water, we ought to treble the amount taken for the uninhabited districts, which give about 1,350 cubic meters more of deposit, to be added to the 88,500 cubic meters that we estimated by calculation. Let us add to this the amount brought by the 6,000 ships which enter the port annually, of which 2,000 merely touch here, and which amount we cannot put down lower than 8,000 cubic meters, and that which comes from the stationary vessels, from the forts, and even from the tides, and our figures swell to 100,000 cubic meters of sediment per year, which we find is proved by comparing the soundings taken at different epochs.*

This great quantity of sediment ought not to astonish us, when we keep in mind the rapidity with which bottoms are filled up in harbors where rivers of any size empty. Venice communicates with the sea by five arms or navigable canals, and from the most remote times the Brenta emptied to the south of Chioggia without damaging the harbor. But in order to avoid the destruction which its spring floods caused in the fields, it was resolved, about forty years ago, to make it empty into the large lake where the harbor is; this immediately began to fill up rapidly, so that already it is difficult for steamers to pass into the fine Lido Canal. It is calculated that about 300,000 tons of deposit a year reaches the Thames at London, an immense quantity for a river whose volume at low water does not exceed one to two thirds of a million cubic meters. From the diagram published by Mr. Eads, of the flow of the waters of the Mississippi, we find that at Columbus, 900 miles from its mouth and the sea, during nineteen weeks, counted from the middle of March to the end of June, 1858, the great "Father of Waters" carried about 20,000 liters of matter in suspension per second, or nearly 1,250,000 of cubic meters per day, a quantity sufficient to close up and fill with earth in twenty days what remains to us of the harbor of Havana.

The effect on our harbor of the deposit from the rain-fall can be condensed into the significant figures which we are going to present.

The harbor, whose total extent, including the entrance channel, is about 1,000 hectares [2,470 acres], is to-day reduced to 820 [2,005 acres], taking as limits the hard beach; but if we consider, as we ought, only that part occupied by the water, this extent is reduced to 600 hectares [1,482 acres]; thus the extent of the 220 remaining hectares [543 acres], or more than one-fourth of what ought to be the harbor, is made land, for the most part a swamp, more or less dangerous and poisonous. In order to show the result as to the whole harbor, we may add that the whole extent covered by water over 8 meters [26¼ feet] deep, is actually reduced to 150 hectares [370 acres], or the one-fourth of the space occupied by the water. The hard beach, which ought to be the limit of the harbor, of 820 hectares, is about 30 kilometers [18¾ miles] around, but the true shore, the actual bounds of the water, is only 22 kilometres [13⅝ miles], of which more than the third part is inaccessible marsh, and there only remains about 14 kilometers [8⅝ miles], less than half of the total length, more or less protected and accessible. We may add that the circumference of the space over 8 meters deep is reduced to 10 kilometers, or 6¼ miles. The figures we have just been giving are only too eloquent, and after giving them it is useless to dwell on them.

It results from all we have shown that even if the annual quantity of sediment emptied into the harbor amounts to 100,000 cubic meters, it will take centuries to obstruct the harbor in such way as to prevent the frequenting of it by vessels of heavy tonnage. We might lose another one-fourth part or even another third of our harbor, which would take many years, and despite all this we would still have a fine port.†

So, if our data, calculations, and reasoning are at all near the truth, the gravity of the evil of which we complain is not precisely that the bottom of the harbor is filling up and that the greater part of its coves is closing up; the evil, in our opinion, depends on the nature, situation, and extent of the zone of marshes, swamps, lagoons, pools, and shallows which surround a great portion of the harbor. There is nothing wanting in these to make them most noxious and dangerous to health. The abounding mass of organic matter, plants, and infinite infusoria, whose rotten detritus insensibly raises the bottom of the harbor and is augmented every year; the alternating rainy and dry seasons; the high temperature which favors the production and action of the pestilential effluvia; the mixture of fresh and salt water, both marshy, in which takes place, with greater strength than in either alone, the formation and emission of deleterious miasma; the situation, the greater part of these marshes being to the windward of the city, so that the miasma reaches the city with facility, because there are no woods to interrupt them, nor any elevation sufficient to escape the influence; for, as Dr. Del Valle has well observed, on the authority of Metcalf and Evans, atmos-

* We have left out of the calculations the deposits produced by the rotting of marine plants and animals, which become of the greatest importance in forming the coast. In Italy they produce one-half of the materials which form the land-making zone, and in the Adriatic it is 70 per cent. of it. (See Ciald Marine Review, 1874.)

† It is probable that the water contained in the harbor at the foundation of Havana was not more than double what it now contains.

pheric currents can transport miasma to considerable distance, even as far as 8 kilometers; and finally the mixture of drainage from dung-hills, back-yards, sewers, and slaughter-pens. And, in order that nothing should be wanting to complete its malignity, the contiguous aquatic zone, which has the bottom covered but slightly with water, contributes also to the production and emanation of miasma. Mr. De St. Venant assures us that if the constant depth of the water is not 35 to 40 centimeters [say 13¾ to 16 inches] the action of light and heat goes on continually, and he demonstrates the greater advantages in this respect enjoyed by steep banks or at least of banks of sufficient height to destroy this action. In this marshy belt, in these 220 hectares [543 acres], of marsh, 25 or 30 more [62 to 74 acres] scarcely covered with water, is where we all see danger. It is for this reason we have said that the dredging of the harbor is only a part of the work to be done, and not the greatest part nor the most urgent of the means to be employed for the sanitation of this city. The dredging deepens the bottom and forms a harbor, but does not sanitate the shores of the coves, which are the centers of infection; nor does it prevent the incessant production of deposits nor destroy the effect of these. What good will it do us to produce a current in the waters of the harbor and to deepen it, while these marshes remain intact, increase, and every day become more active in their effects? It is necessary, urgent, and indispensable to deepen the harbor, but it is not less, but more urgent to sanitate its shores and destroy or prevent the repetition of the evil. It would seem at first sight, that if we would establish strong currents of clear water, starting from the shores of the coves, these would be sufficient to remove, drag away, and carry off, to some miles distant from our port the sediment of the harbor, and that there would follow in time not only its cleansing, but also some amelioration of the condition of its shores. Without doubt this is what the authors proposed to do in those plans which have lately been laid before the public, especially in the plan of Dr. Argumosa.

Let us see, after all the preceding facts, what will probably happen if the canal proposed by this gentleman were constructed.

IV. If the canal be dug where easiest and most convenient it would be 3,175 meters [3,471 yards] long from the mouth of the slaughter-house drain to the sea at San Lazarus. Its width, according to Mr. Argumosa, would be 12 meters [39¼ feet], its depth from 8 to 10 [26 to 33 feet]. Two-thirds of its length, the embankment and the canal, are to be walled in with hewn stone, and the other third being through rock would not need to be thus walled; and throughout the whole length the crowning wall is to be 2 meters [6½ feet]. We calculate 200 meters width for the land purchased and fitted up on both sides of the canal so as to build on it stores, quays, &c., to connect this land with the villages; this would give an area of 63½ hectares. To afford access to the canal and put it in communication with the harbor, it would be positively necessary to continue the canal through the low lands as far as Paula, about 2 kilometers, in order to get a depth of 8 meters. Add to this the filling up of the many streets and roads traversed by the canal, and the construction of bridges sufficiently high to allow boats to pass under them, though these should be without chimneys, or with chimneys having revolving caps. These bridges would at first be twenty, and later the number would be doubled. The cost of all this work and of the land purchased we calculate at about $7,000,000, without counting the building of stores and dwellings, landings and other necessary appurtenances; with these last the sum would probably amount to something like $9,000,000. We do not believe that the revenues of the canal and the sale of the lands will suffice to secure this capital at a moderate interest. But, let us suppose all the work done to connect the harbor with the sea, and the affairs in the hands of a company, as proposed by Mr. Argumosa; let us see what will probably happen when once this connecting canal is established.

Every word is an expression of an idea, and every qualifying word defines in some sense the thing referred to, and attributes to it a certain value. The expression "drainage canal" has been used by Mr. Argumosa and by others in connection with this enterprise; and the idea that this expression calls up has brought with it the error of considering this canal as a work of the highest importance, when really it is not. Is the proposed canal a drainage canal? Will it, as such, contribute to the amelioration of the harbor of Havana? Will it produce the hygienic advantages claimed for it by Mr. Argumosa? It is easy to show that it will not, and the whole value of the idea is the ardent desire to be useful to this city, which idea has moved its worthy author to propose it in so many eloquent words.

If, at the extremity of the harbor of Havana, the water was at a considerable height above the level of the sea at the little bay of San Lazarus, so that there could be dug a canal with a steep descent from the first point to the second, we might understand the possibility of a draining current from the harbor, in addition to what would take place, on the same hypothesis, at the mouth of the harbor; but as nothing of this kind happens, and as the harbor may be considered as a continuation of the North Atlantic, the canal in question will do nothing more than duplicate the communications between two portions of the same mass of water. Without the winds, the tides, and the emptying of fresh water into the harbor, the canal and the sea on

the north shore would constitute one and the same circuit of still water, which throughout its whole extent would keep at exactly the same level, hence there could not be any drainage.

Now let us examine how far the slight alteration of the usual level can influence the motion of the waters of the harbor and of the canal; and whether there be any reasons, however slight, to suspect that there can or will be established any current whatever, capable of realizing the idea that the projected canal can be of use to drain the harbor of Havana. The agitation caused by the wind on the surface of the waters is proportionate to its violence and the area open to it, because its form is very much that of a circle of the same superficial extent; the direction and the inclination of the wind is also influenced by the depth of the water and the inclination and situation of the surrounding land. In a canal more than 3 kilometers long, and only 12 meters wide, caged in, so to speak, between high walls and situated in the lowest land of Havana, the action of the wind, unless of extraordinary violence and in the same direction as the canal, may be considered as insignificant. This is not the case in the harbor, which is almost as wide as it is long, and whose center spreads out an unobstructed liquid field, whereon is exercised, almost freely, the whole strength of the wind, which keeps the surface in an almost constant state of agitation, which sometimes equals that of the exterior sea. The hurricanes sometimes gather up and dash on the shore large masses of water, but beyond these exceptional cases, the winds only produce the slightest undulation of the surface, which does not alter in any way the general level. As to the coves of Tallapiedra and Atares, from which the canal would start, and which have been so graphically described by Mr. de Pichardo, they are precisely, as observed and proved by Mr. de Paradela, the places in all the harbor least agitated by the winds. They are almost always in perfect repose. It seems as if the perfidious calm of their waters were in proportion to the quantity of deadly elements they contain. There is, then, nothing in the action of the winds to justify the idea that this canal would be a drainage canal.

In order to be able to appreciate the effect of the currents of fresh water which empty into the harbor, it would be necessary to ascertain with exactness, or to nearly approximate the respective volumes; but this not being possible at present, we will limit ourselves to an estimate, which cannot be very far from the truth. There empty into the harbor, besides the Triscornia and Marimelena creeks, nearly always dry, the before-mentioned rivers, Guasabacoa, Martin Perez, the Luyano, the Valiente Creek, and the Little Carraguao, united by branches with the Zanja Real, the Giónaga, and the Matadero. In the usual dry season the drainage of all these together may amount to from 40,000 to 45,000 cubic meters of water a day, or ½ cubic meter a second. The harbor, excluding the entrance channel, contains about 30,000,000 cubic meters, and that not only in the dry season, but as well in the rainy season, when the volume of all these creeks is extraordinarily augmented. The effect on the great mass of water in the harbor is the more insignificant from the fact that the fresh waters float on the top of the sea water, in consequence of being less dense, until they are dissipated or lost, so to speak, in the extension of the harbor. As to the canal, its influence would not be any stronger. The quantity of water contained in the canal, calculating from its entrance into the Atares Cove, would be about 500,000 cubic meters. The proportion between the affluent waters and the mass contained in the canal would be about a millionth per second, and the velocity it would give to the waters of the canal would be well represented by a cypher. This is supposing, too, that all the water of these streamlets would flow to the mouth of the canal, which positively will not happen; to be certain of this, it is only necessary to cast a glance on the plan, and to consider the situation of these drains in relation to the harbor, and to the canal. The water of this last, then, would remain always permanently tranquil, nearly all the year round, in spite of the little rivulets which empty into the harbor.

Let us see if we can do better with the effects of the tides. On all the north coast of the island, as well as on Cayo Hueso, the Tortugas, &c., the tides average a height of 1½ feet, or 45 centimeters. The laws of the tides in the harbor of Havana, settled by the hydrographic commission of the island of Cuba in 1860, give, as a maximum height of high tide above low tide at the Capitania of the harbor, 720 millimeters [28½ inches], and at the mouth of the arsenal only 557 millimeters, or 22 inches. The high tide at the first point is at 14 minutes past eight o'clock, and at the second point at 39 minutes past eight o'clock, so that there is a difference of 25 minutes in the rising of the tide along the two kilometers of the shore of the harbor from the Capitania to the arsenal, which gives a mean velocity of 1¼ meters per second, losing 163 millimeters, or 7 Spanish inches, of its height at spring tide, and proportionately at the others. But this is an exceptional maximum, and as a general average for the year we can, if we wish, take for our argument 30 centimeters, [about 12 inches,] as high tide at the mouth of the Matadero channel. The velocity of the tide currents is much less in the harbor than that which causes the undulation or rising of the water. Putting aside this last phenomenon, which does not concern us, and attending only to the currents of the ebb and flow, we find that constant observation of its action in many

ports shows that up to a certain point, contrary to the general hydronamic theory, the flow is frequently more powerful and more rapid than the ebb. We have not at hand any notes relative to this point in our harbor, but let us suppose from general observations that the same thing happens here; the progress and effects of these currents are easily explained, but the whole on a scale proportionate to its smallness.

As the same volume of sea water comes in with the flow and goes out with the ebb, it might be believed that the quantity of matter brought in by the flow would all go out to the sea again with the ebb without any effect on the bottom of the harbor, but this does not really take place. The entrance channel to our port, about 1¼ kilometers (four-fifths of a mile) in length, is relatively narrow, as it is only 250 meters, or 275 yards wide at the Cabelleria wharf, diverges, opens, spreads, runs slower and slower, depositing the matter with which it is charged, making bars principally at the place opposite its entrance into the harbor. When the change of tide takes place the ebb acts in a contrary manner. At first it runs slowly and softly, slipping along the bottom; it runs on, increasing its velocity little by little, flowing on all sides towards the mouth, removing much of the deposit left by the flow and taking more time than the flow; it reaches at last the entrance channel, where it acquires all the rapidity given by the difference of level between the harbor and the sea.

The canal of San Lazarus once cut, the current of the flow will come into it at the same time as at the entrance to the harbor, but it will not diminish as in the harbor in consequence of the uniformity of the canal; if it is not accelerated, at least it will keep on running at the same rate. In every way the tide will reach the creek through the canal a great deal sooner than it will reach it by the harbor; and it is probable that both currents will meet towards Cayo Cruz [which is very near the southern extremity of the harbor]. At the setting in of the ebb the same thing will happen as we explained in reference to the harbor, only it will acquire a great velocity while still in the canal; and consequently, the canal will be of use only to this current, but will not succeed in returning to the sea all the quantity of matter introduced into the creek by the flow-tide. So that if the facts are verified, and we think they probably can be, then after constructing the canal it would prove instead of an aid to the cleansing of the harbor only one additional means for the sea to deposit its detritus in it. This effect, however, would be of the slightest importance on account of the narrow breadth of the canal and the low height of the tides; the velocity of the current of the descent in the canal we can calculate at 15 centimeters per second.*

If we set aside, as we can do the slight causes which prevent the absolute tranquility of the water, we can consider the sea at San Lazarus, the harbor, and the canal as one and the same basin of water, which by a well-known hydrostatic law will always maintain the same level.

From these arguments we deduce the following conclusions: If the canal is made, nothing will be effected except to make the sea and harbor communicate by means of a second mouth without changing the height of the water nor its motions in the harbor, except in the slightest and in a completely unnoticeable manner; that it would be improper to call the canal a "drainage canal"; that on the contrary it will form a depot for stagnant water, with only the slight movement imparted by the tides.

Until now we have set aside all extraordinary rainfalls which happen during hurricanes and violent storms. In these cases the canal as well as the harbor would become a real drain for the immense quantity of water which would spread all over the basins of the affluents whose detritus and sediment would settle in it as well as in the harbor, filling up the bottom and slowly closing the canals.

As the wind cannot influence in an efficacious manner the water of the canal, nor the slow motion of the tide produce in it a current of violence, its waters would be in a worse condition than those of the harbor; the deposit from the rain would produce in it on account of its slight width greater changes and its depth would be diminished with much greater rapidity; the noxious matter with which its waters would be mixed would be proportionately more abundant and would make them every day more unhealthy; and in a word, this canal, from its situation in the lowest part of the marsh and from its narrow width, will acquire all the disadvantages and inconveniences of an open sewer, without any of its advantages. For a sewer, with an equal slope at the bottom, in the place of this canal would drain thoroughly the high lands; the waters would run through it, and it would besides be covered, so that its emanations would not be noxious. A canal, the continuation of the miry bottom of the harbor, which can with reason be considered as stagnant water and which would receive the deposit of nearly all the basin, lying between the Arostegui Hill, the Cerro, and the city, far from contributing to ameliorate the public health would, we believe, constitute a new focus of infection, and the most elementary hygiene ought to proscribe it absolutely.

The work proposed also appears to me impossible to be executed, economically speak-

* It is necessary that the velocity of a current should be 15 centimeters per second to carry off particles of coarse, loose sand, and the velocity must be double that to wash off fine sand.

ing, prejudicial to the defense of and inconvenient for the city; that it would not drain the harbor nor contribute to its cleanliness; and it is inadmissible under a hygienic aspect.

We have not dwelt longer than was necessary on the preceding observations, seeing the great importance of the project and the respect due the illustrious corporation which has asked for information, the great wisdom which has had the kindness to listen to us, and the particular consideration due to the high place and the elevated conception of the worthy gentleman who proposes the execution of this work. What a pity that he did not direct his generous efforts to the execution of other projects of known efficacy to obtain the same end, and prayed for by this people for many years—true means, to which the city acknowledges that its present amount of health is due, and without which its existence would already be precarious. The abundant supply of good water, indispensable base and beginning of all hygienic measures, the underground sewering of the city, with the suppression of privy vaults and sinks, and the plentiful and well-directed planting of trees at all necessary points—these objects are worthy of most serious attention from the municipal corporation.

V. We must now fix the consideration and call the attention of the academy to one part of the proposition of Mr. Argumosa. He considers it as a consequence or adjunct of the canal project, whereas we consider it, on the contrary, as the principal, or rather as the only really useful and beneficial portion of the plan presented. Mr. Argumosa speaks of the convenience of filling up and improving by cultivation and by other artificial means the low shores, the marshes, and the belt of shallows, which bound our harbor on the greater part of its perimeter. With this we perfectly agree. This and the revetment of the mouths of the rivers are proposed as an addition to the official project of cleansing the harbor of which we have spoken. Here Mr. Argumosa is on the right track. He proposes a thing useful, practicable, economical, and, what is more, indispensible to the sanitation of the city and harbor, and worthy of the approval of this illustrious academy.

But unfortunately, gentlemen, it will not be enough to cleanse the harbor and its encircling marshy shores, nor to wall in the mouths of the rivers, even if these ameliorations could be realized at the same time with the ample introduction of the always much-desired waters of the Vento, and with the best system possible of underground sewerage, and with other hygienic measures that the city imperiously demands. These all would not be enough, I say, for the complete sanitation of the city and its harbor as long as we do not attend with especial care to the planting of trees, which are not one of our least wants, yet have not been mentioned by any of the authors of recent projects. A deep sadness fills the soul of the man who loves this city when he sees the naked hills, the bare fields, their former luxuriance gone, and not a single grove in the whole basin of the city. This sadness is augmented and mingled with indignation when he recognizes that such criminal devastation, such sinful negligence, has been the cause in a great measure of our bad sanitary condition. Lying beneath our incomparable sky, in the midst of our perpetual spring, with its balmy breezes, with all the necessaries of life abundant, with the perfect salubrity that nature has lavished upon us prodigally, the world points out Havana with horror, and justly, too, as the most fearful center of infection, and there come to us every year to die thousands of our brothers from other climes.

How different from what we now see did the primitive harbor of Havana appear three hundred and seventy years ago to the amazed and charmed eyes of Sebastian de Ocampo. He gazed on the odoriferous trees of the virgin forest which encircled the harbor, on the clear and deep waters; and in the shade glided along, clear as crystal, the little rivers and brooks which, without other *débris* than the fallen leaves and a little fine sand, emptied slowly and softly into the wide, clear coves. Judging from the descriptions and the coarse, primitive engravings which have come down to us from those early days, nearly the whole extent of the shore was approachable and crowned with luxuriant trees, such as the mahogany, the cedar, the date, plum, fir, red-wood, tamarind, the thick sciba, the tall palm, and many others of minor importance; they formed a wide barrier against the washing of the rain, and united in this way convenience and utility to the beauty of their majestic and picturesque appearance. But in this beautiful unknown corner, where nature seemed to have taken refuge, to spread out alone and silently, under the vivid sun of the tropics, its most splendid treasures, man at last planted his foot, civilized man, who sometimes corrects and ameliorates nature, and then again abuses her with an ungrateful want of foresight. One of his first acts on taking possession of this blessed land was to use without stint the forest, destroying the woods which protected the harbor, clearing the hillsides and slopes, and bringing on the ravages caused by the rise of these same rivers and brooks, once so inoffensive, but which now, with the *débris* of the stripped lands around, have succeeded in filling up a greater part of the harbor, and brought us to the condition which we contemplate to-day with fear and grief.

The woods are powerful defenders of the highlands against floods, besides exercising their beneficent and regulating influence on the temperature, the winds, the rains,

the distribution of the waters, and on other climatic, agricultural, and hygienic conditions; trees are destined by nature to preserve the fertility of the highlands, being barriers against landslides and their fatal consequences. The law is universal; destroy the woods and you will fatally change the climate; and the irregularity and excess of the rains, the torrent-like swelling of the rivers and brooks, the forlorn nakedness of the heights, the sterility of the fields, and the unhealthiness of the country will be the fatal chastizing results of such destruction. The extraordinary efforts, the constant labor, and the obstinate struggle of the art of preserving forests in the most civilized countries (great and admirable results of which were presented at the last Paris Exposition), proclaim the importance, demonstrate the necessity, and teach at the same time the means to preserve the lands, to improve them, and to keep or restore their productive qualities. It appears evident to us that the first and principal cause of the filling up of our beautiful harbor has been the clearing of the lands that form the basin of its affluents; consequently, the complete destruction of the woods that covered them formerly. We believe that a wise replanting of many trees, according to the rules of the useful and at present advanced art of horticulture, is one of the principal measures on which we should rely for restoring to the surroundings of Havana its primitive fertility, and for re-establishing and reconstructing what nature had done; with this will disappear the principal cause of the filth of our harbor, and its disastrous consequences.

Let us insist again and again that no land should be granted on the shores of the harbor, except with the clause that trees shall be planted on it under the conditions prescribed by our illustrious engineer, De Montes; and this should be done as much as possible in order to extend this arboreal restoration under these conditions to the whole basin of Havana, in order to attain the beneficent results which you perfectly understand, the immense advantage of making the land stable, and preventing greatly for the future the filling up of our harbor.

VI. We will then propose respectfully to the academy the following conclusions:

1st. That the council be informed that this academy does not indorse the views of Mr. De Argumosa on the construction of a navigable canal between the harbor and San Lazarus, because such a canal would not be as useful and as advantageous as its author supposes.

2d. That on the other hand, this academy recommends strongly the second and last part of the project of Mr. De Argumosa, in order that, without loss of time, we should begin to inclose with walls or revetments, and to fill up the marshy belt or low land which surrounds the greater part of the harbor and constitutes a powerful center of infection. This academy insists on the necessity of planting trees on this land as well as on other portions of the basin of Havana, in order to prevent the descent of mud which fills up the harbor of Havana. But all this should be done without stopping the present means employed for clearing out the harbor.

3d. That the academy takes this occasion to declare that it judges it an indispensable necessity for the public health that the Vento water should be promptly introduced and amply distributed; that there should be established a good system of underground sewerage; that wells, privy-vaults, and sinks should be suppressed; and that the extensive planting of trees, properly distributed, should be encouraged in all the country surrounding the city.

These conclusions and this report were approved and adopted by the academy.

This admirable report does not apparently dispose conclusively of the proposition of Dr. Burgess and some others to the following effect: "It is believed that the water of the harbor can be cleansed by the construction of an artificial canal, which would admit the Gulf Stream, ever flowing at the rate of four to five miles along our immediate coast. There is every reason to believe that this Gulf Stream current could be seized at some projecting point of the coast very near to Havana, or be caught by a wing-dam and conducted into the harbor."

CHAPTER XXIII.

REPORT OF MESSRS. ARIZA AND HERRERA, THE OFFICIAL CIVIL ENGINEERS OF THE CITY OF HAVANA.

TABLE No. 18.—*Area and elevations of 36 wards of Havana, with the number of houses and of inhabitants.*

A.—HAVANA (OLD TOWN).

Districts.	Wards.	Surface in square meters of— Wards.	Vacant spaces.	Buildings and streets.	Number of houses.	Number of inhabitants.	Surface in square meters per inhabitant.
First	1st. Templete	101, 230	32, 400	68, 830	176	2, 700	37. 50
	2d. San Felipe	115, 700	....	115, 700	313	3, 150	36. 73
	3d. Santo Cristo	99, 000	5, 000	94, 000	396	3, 810	25. 98
	4th. San Juan de Dios	171, 850	4, 350	167, 500	301	3, 810	45. 10
	5th. Sto Angel	99, 260	....	99, 260	427	3, 770	26. 32
		587, 040	41, 750	545, 290	1, 613	17, 240	34. 05
Second	1st. San Francisco	96, 000	5, 000	91, 000	194	3, 340	28. 74
	2d. Santa Clara	143, 100	....	143, 100	361	4, 000	35. 77
	3d. Santa Feresa	127, 800	980	126, 820	467	5, 720	22. 34
	4th. Paula	108. 200	7, 500	100, 700	385	3, 580	30. 22
	5th. San Ysidro	139, 100	1, 900	137, 200	631	6, 000	23. 18
		614, 200	15, 380	598, 820	2, 038	22, 640	26. 79

Districts.	Wards.	Average of inhabitants per house.	Levels in meters. Heights.	Average level of high ground.	Low ground.	Average level of low ground.	Average level of ward.
First	1st. Templete	15. 34	3. 00 & 2. 00	2. 50	1. 00 & 1. 00	1. 00	1. 750
	2d. San Felipe	10. 6	4. 00 & 3. 50	3. 75	3. 00 & 2. 00	2. 50	3. 125
	3d. Santo Cristo	9. 62	8. 30 & 7. 00	7. 65	4. 00 & 3. 50	3. 75	5. 700
	4th. San Juan de Dios	12. 65	3. 50 & 2. 00	2. 75	1. 00 & 1. 00	1. 00	1. 875
	5th. Sto Angel	8. 82	8. 00 & 7. 00	7. 50	3. 50 & 2. 00	2. 75	5. 125
		10. 68	....	4. 83	....	2. 20	3. 515
Second	1st. San Francisco	17. 21	2. 70 & 4. 50	3. 60	1. 00 & 1. 00	1. 00	2. 30
	2d. Santa Clara	11. 8	7. 50 & 3. 50	5. 50	4. 50 & 2. 70	3. 60	4. 55
	3d. Santa Feresa	12. 24	10. 00 & 8. 00	9. 00	7. 50 & 3. 50	5. 50	7. 25
	4th. Paula	9. 29	5. 50 & 4. 50	5. 00	2. 00 & 2. 00	2. 00	3. 50
	5th. San Ysidro	9. 50	9. 25 & 4. 75	7. 00	2. 00 & 2. 00	2. 00	4. 50
		11. 10	....	6. 02	....	2. 82	4. 42

REMARKS.—Havana (old town) is that part of the city between the old walls, demolished a few years ago, and the wharves. The levels are from high tide, which is 88 inches above low-water mark.

TABLE No. 18.—*Area and elevation of 36 wards of Havana, &c.*—Continued.

B.—RÉSUMÉ OF HAVANA (OLD TOWN).

Number of districts.	Number of wards.	Total meters. Surface of districts.	Total meters. Of the vacant spaces.	Total meters. Buildings and streets.	Total of houses.	Total of inhabitants.
Two	Ten	1, 201, 240	57, 130	1, 114, 110	3, 651	39, 880

Number of districts.	Number of wards.	Average surface per inhabitant.	Average inhabitants per house.	Levels in meters. Heights.	Levels in meters. Low ground.	Levels in meters. Average of the old town.
Two	Ten	30. 12	10. 92	5. 425	2. 510	3. 967

C.—HAVANA (NEW TOWN).

Districts.	Wards.	Surface in square meters of— Ward.	Surface in square meters of— Vacant spaces.	Surface in square meters of— Buildings and streets.	Number of houses.	Number of inhabitants.	Surface in square meters per inhabitant.
Third	1st. Punta	255, 700	145, 000	110, 700	673	10, 110	25. 29
	2d. Colon	265, 130	27, 000	238, 000	699	8, 160	32. 49
	3d. Tacon	274, 000	40, 000	234, 000	248	3, 780	72. 48
	4th. Marte	145, 000	45, 800	99, 200	487	4, 680	30. 98
		939, 830	257, 800	682, 030	2, 107	26, 730	40. 31
Fourth	1st. Monserrate	214, 600	24, 000	190, 600	769	8, 370	25. 63
	2d. Dragones	231, 650	5, 200	226, 450	454	5, 580	41. 51
	3d. Guadalupe	156, 000	0	156, 000	611	7, 120	21. 91
	4th. San Leopoldo	182, 200	14, 200	168, 000	633	6, 000	30. 36
		784, 450	43, 400	741, 050	2, 467	27, 070	28. 97
Fifth	1st. Arsenal	303, 000	25, 000	278, 000	537	5, 140	58. 94
	2d. Seiba	112, 800	0	112, 800	625	6, 455	17. 47
	3d. Jesus Maria	144, 700	53, 700	91, 000	334	3, 030	47. 75
	4th. Vives	101, 200	6, 750	94, 450	528	4, 440	22. 79
		661, 700	85, 450	576, 250	2, 024	19, 065	34. 70
Sixth	1st. San Nicollas	110, 300	0	110, 300	536	5, 420	20. 35
	2d. Peñalver	181, 450	38, 300	143, 150	705	7, 010	25. 89
	3d. Chavez	91, 400	17, 500	73, 900	610	6, 200	14. 75
	4th. Pilar	149, 000	94, 000	55, 000	564	5, 080	29. 33
	5th. Atarés	757, 500	535, 000	222, 000	254	4, 650	162. 68
		1, 289, 650	685, 300	604, 350	2, 669	28, 360	45. 47

TABLE No. 18.—*Area and elevation of 36 wards of Havana, &c.*—Continued.

C.—HAVANA (NEW TOWN)—Continued.

District.	Wards.	Surface in square meters of— Ward.	Vacant spaces.	Buildings and streets.	Number of houses.	Number of inhabitants.	Surface in square meters per inhabitant.
Seventh	1st. San Lázaro	1, 047, 500	457, 500	590, 000	399	7, 740	135. 27
	2d. Pueblo Nuevo	923, 100	844, 600	78, 500	463	5, 937	155. 48
	3d. Principe	5, 129, 300	5, 129, 300	0	126	1, 062	4, 867. 00
	4th. Vedado	3, 634, 600	3, 150, 600	484, 000	216	1, 418	2, 563. 00
		10, 734, 500	9, 582, 000	1, 152, 500	1, 204	16, 157	664. 38
Eighth	1st. Jesus del Monte	1, 353, 000	744, 000	609, 000	978	7, 593	178. 19
	2d. Luyanó	4, 356, 700	4, 296, 700	60, 000	104	1, 191	3, 658. 00
	3d. Arroyo-Apolo	15, 260, 000	15, 080, 000	180, 000	265	2, 638	5, 784. 00
		20, 969, 700	20, 120, 700	849, 000	1, 347	11, 422	1, 835. 00
Ninth	1st. Villanueva	532, 400	152, 400	380, 000	289	4, 335	122. 81
	2d. Cerro	3, 598, 600	2, 628, 600	970, 000	752	6, 454	557. 57
		4, 131, 000	2, 781, 000	1, 350, 000	1, 041	10, 789	383. 00

Districts.	Wards.	Average of inhabitants per house.	Levels in meters. Heights.	Average level of high ground.	Low ground.	Average level of low ground.	Average level of ward.
			M. *M.*				
Third	1st. Punta	15. 2	5. 50 & 4. 00	4. 75	1. 00 & 1. 00	1. 00	2. 875
	2d. Colon	11. 67	9. 00 & 7. 00	8. 00	5. 50 & 4. 00	4. 75	6. 875
	3d. Facon	15. 24	14.75=12.50=10.00	12. 41	9. 00 & 7. 00	8. 00	10. 205
	4th. Marte	9. 60	10. 00 & 14. 50	12. 25	7. 00 & 7. 00	7. 00	9. 625
		12. 88	....	9. 852	....	5. 187	7. 270
Fourth	1st. Monserrate	10. 88	8. 50 & 8. 50	8. 50	1. 00 & 1. 00	1. 00	4. 750
	2d. Dragones	12. 29	16. 00 & 14. 50	15. 25	8. 50 & 8. 50	8. 50	11. 875
	3d. Guadalupe	11. 65	21. 50 & 16. 00	18. 75	8. 50 & 8. 50	8. 50	13. 625
	4th. San Leopoldo	9. 47	8. 50 & 8. 50	8. 50	1. 00 & 1. 00	1. 00	4. 750
		10. 97	....	12. 75	....	4. 75	8. 750
Fifth	1st. Arsenal	9. 57	13. 00 & 10. 00	11. 50	0. 50 & 0. 50	0. 500	6. 000
	2d. Seiba	10. 82	14. 50 & 13. 00	13. 75	4. 75 & 1. 50	3. 125	8. 437
	3d. Jesus Maria	9. 7	5. 00 & 5. 00	5. 00	0. 50 & 0. 50	0. 500	2. 750
	4th. Vives	8. 40	3. 00 & 4. 00	3. 50	0. 25 & 0. 25	0. 250	1. 875
		9. 41	....	8. 44	....	1. 094	4. 765
Sixth	1st. San Nicolás	10. 11	12. 00 & 7. 00	9. 50	2. 00 & 1. 75	1. 875	5. 687
	2d. Peñalver	8. 94	23. 50 & 23. 50	23. 50	6. 00 & 6. 00	6. 000	14. 750
	3d. Chaves	10. 16	11. 00 & 2. 50	6. 75	0. 70 & 0. 70	0. 700	3. 725
	4th. Pilar	9. 00	16. 00 & 3. 50	9. 75	0. 50 & 0. 50	0. 500	5. 125
	5th. Atarés	18. 27	11. 50 & 6. 00	8. 75	0. 00 & 0. 00	......	4. 375
		10. 62	....	11. 65	....	1. 815	6. 732

TABLE No. 18.—*Area and elevation of 36 wards of Havana, &c.*—Continued.

C.—HAVANA (NEW TOWN)—Continued.

Districts.	Wards.	Average of inhabitants per house.	Levels in meters.				
			Heights.	Average level of high ground.	Low ground.	Average level of low ground.	Average level of ward.
			M. *M.*				
Seventh	1st. San Lázaro..........	19.40	18.00 & 14.00	16.00	1.00 & 1.00	1.00	8.50
	2d. Pueblo Nuevo.......	12.82	21.00 & 11.00	16.00	3.50 & 0.50	2.00	9.00
	3d. Principe............	8.42	43.00 & 30.00	36.50	12.50 & 3.50	8.00	22.25
	4th. Nedado............	6.56	5.00 & 4.00	4.50	0.50 & 0.50	0.50	2.50
		13.42	....	18.25	....	2.875	10.562
Eighth	1st. Jesus del Monte....	7.77	67.00 & 31.50	49.25	0.50 & 0.00	0.25	24.750
	2d. Luyanó	11.45	....	......	....	......	*12.000
	3d. Arroyo-Apolo	9.95	....	......	....	......	......
		8.47	....	......	....	......	18.375
Ninth........	1st. Villanueva.........	15.00	24.50 & 12.00	18.25	3.50 & 3.00	3.25	10.75
	2d. Cerro..............	8.58	36.50 & 22.00	29.25	7.00 & 3.00	5.00	17.12
		10.35	....	......	....	......	†16.155

* Estimated. † Arroyo-Apolo ward not included.

D.—RÉSUMÉ OF HAVANA (NEW TOWN).

Number of districts.	Number of wards.	Surface in meters.			Number of houses.	Number of inhabitants.	Number of inhabitants per house.	Levels: average level of new town in meters.
		Total surface.	Vacant spaces.	Houses and streets.				
7	26	39,510,830	33,555,650	5,955,180	12,859	139,593	10.85	10.372

REMARKS.—Districts Nos. 7, 8, and 9, and the Fifth ward of the Sixth district, are sparsely built. The mean level noted in this sheet does not include the levels in the Arroyo-Apolo ward, as none have been taken there.

E.—RÉSUMÉ OF THE DENSELY POPULATED PART OF THE CITY.

[Includes the first, second, third, fourth, and fifth districts, and S. Nicolás, Penalver, and Chavez y Pilar wards of the sixth district.]

Surface in square meters:
- Total surface 4,119,370
- Vacant spaces 593,580
- Occupied by houses and streets 3,525,790

Number of inhabitants 136,455

Each inhabitant has of—
- Total surface ....sq. meters.. 30.188
- Space occupied by houses and streets ....do.. 25.830

Number of houses 12,664

Average number of inhabitants per house 10.77

Level in meters:
- Heights 8.9612
- Low ground 3.0533
- Average level 6.007

Havana, September 30, 1879.

ANTONIO ARIZA,
ANTONIO GONZÁLEZ Y HERRERA,
City Engineers of Havana.

TABLE No. 19.—*Havana, its surface and population.*

	Surface in square meters.	Inhabitants.	Surface per inhabitant.
Part densely populated	4,119,370	136,455	30.188
Part sparsely populated	5,571,100	43,018	129.50
Part consisting of vacant lots	31,021,600		
Total	40,712,070	179,473	79.84

REMARKS.—Regarding the part densely populated see table No. 10 E.

The part sparsely populated consists of the fifth ward, sixth district, first and second wards, and parts of the third and fourth wards of the seventh district, a part only of the third ward of the eighth district, and a part of the second ward of the ninth district.—A. and H.

[While Messrs. Ariza and Herrera specify in these tables the total population of Havana to be 179,473 + 7,227, or 186,700, one official report gives the same population 199,082, and still another, which is believed to be the more correct, gives the civil population as 195,437. This is increased by from 5,000 to 20,000 military and floating population.—S. E. Chaillé.]

The following is the number of inhabitants and houses in the suburban villages of Puentes-Grandes, Arroyo-Naranjo, Calvario, and Casa-Blanca; though they are within the municipal limits of Havana they were not included in the foregoing table.

	Inhabitants.	Houses.
Puentes-Grandes	2,550	331
Arroyo-Naranjo	1,822	164
Calvario	1,210	110
Casa-Blanca	1,645	144
Total	7,227	749

Including these figures there is a total of 186,700 inhabitants living in 17,259 houses within the corporate limits of Havana. Estimating the military and floating population at 20,000 there would be a total of 206,700 inhabitants in the city.

Havana, October 11, 1879.

ANTONIO ARIZA,
ANTONIO GONZALEZ Y HERRERA,
City Engineers.

TABLE No. 20.—*Population of Havana in paved and unpaved streets.*

Surface of paved streets in old town	127,700
Surface of paved streets in new town	124,800
Total surface	252,500
Population living in paved streets:	
Old town	31,540
New town	21,300
	52,840

	Inhabitants.			Proportion of inhabitants in paved streets.
	Totals.	In paved streets.	In unpaved streets.	
Old town	39,880	31,540	8,340	79.08
Densely populated part of new town	96,575	21,300	75,275	22.05
Sparsely populated part of new town	43,018		43,018	
	179,473	52,840	126,633	29.44

Havana, October 11, 1879.

ANTONIO ARIZA,
ANTONIO GONZALEZ Y. HERRERA,
City Engineers.

TABLE No. 21.

A.—LOW GROUNDS OF HAVANA.

Districts.	Wards.	Inhabitants.		Surface in meters in districts.	Number of houses.	
		Wards.	Districts.		Wards.	Districts.
First	1st. Templete	1,230	4,680	239,690	80	380
	2d. San Felipe	1,290			128	
	4th. San Juan de Dios	2,160			172	
Second	1st. San Francisco	120	120	21,000	7	
Third	1st. Punta	1,020	2,443	214,000	679	801
	2d. Colon	1,423			122	
Fourth	1st. Monserrate	1,044	1,394	49,660	96	133
	4th. San Leopoldo	350			37	
Fifth	1st Arsenal	48	4,680	200,600	5	540
	2d. Seiba	590			57	
	3d. Jesus Maria	182			20	
	4th. Vives	3,860			458	
Sixth	3d. Chavez	5,000	5,761	143,690	492	555
	4th. Pilar	378			42	
	5th. Atarés	383			21	
Seventh	1st. San Lázaro	520	1,020	235,900	26	102
	4th. Vedado	500			76	

REMARKS.—That part of Havana not over two meters above high tide is reckoned as low ground.

Surface of meters in low ground	1,104,548
Population	20,090
Percentage of population in—	
Densely populated part	14.72
Total surface of city net, including outlying wards	11.20
Total surface within municipal limits	9.70
Surface per inhabitant	54.95
Houses	25.18
Persons per house	7.98

Havana, October, 1879.

ANTONIO ARIZA,
ANTONIO GONZÁLEZ Y HERRERA,
City Engineers.

B.—PEOPLE LIVING IN HOUSES OVER TWO AND LESS THAN FOUR METERS ABOVE HIGH TIDE.

Districts.	Wards.	Inhabitants.		Surface in meters of districts.	Number of houses.	
		Wards.	Districts.		Wards.	Districts.
First	1st. Templete	1,470	6,962	249,000	96	628
	2d. San Felipe	1,860			185	
	3d. Santo-Cristo	924			96	
	4th. San Juan de Dios	1,632			129	
	5th. Sto. Angel	1,076			122	
Second	1st. San Francisco	3,132	6,926	218,812	182	560
	2d. Santa-Clara	1,706			154	
	4th. Paula	1,746			188	
	5th. San Ysidro	342			36	
Third	1st. Punta	1,022	4,394	166,375	52	341
	2d. Colon	3,372			289	
Fourth	1st. Monserrate	3,330	4,660	148,312	306	552
	4th. San Leopoldo	1,330			246	
Fifth	1st. Arsenal	....	2,945	120,425	....	316
	2d. Seiba	1,114			108	
	3d. Jesus Maria	1,251			138	
	4th. Vives	580			70	
Sixth	1st. San Nicolás	1,708	4,770	87,187	169	427
	3d. Chavez	1,200			118	
	4th. Pilar	675			75	
	5th. Atarés	1,187			65	
Seventh	1st. San Lázaro	2,580	3,240	300,000	134	234
	4th. Vedado	660			100	

Havana, October, 1879.

ANTONIO ARIZA,
ANTONIO GONZALEZ Y HERRERA,
City Engineers.

C.—POPULATION LIVING IN HOUSES AT LOW, MEDIUM, AND HIGHEST LEVELS ABOVE HIGH TIDE.

Districts.	Surface in meters.				Inhabitants.			
	Low grounds.	Medium levels.	Heights.	Totals.	Low grounds.	Medium levels.	Heights.	Totals
First	239, 690	249, 000	98, 350	587, 040	4, 680	6, 962	5, 598	17, 240
Second	21, 000	218, 812	374, 388	614, 200	120	6, 926	15, 594	22, 640
Third	214, 000	166, 375	559, 455	939, 830	2, 443	4, 394	19, 893	26, 730
Fourth	49, 660	148, 312	586, 478	784, 450	1, 394	4, 660	21, 016	27, 070
Fifth	200, 600	120, 425	340, 675	661, 700	4, 680	2, 945	11, 440	19, 065
Sixth	143, 690	87, 187	1, 058, 773	1, 289, 650	5, 761	4, 770	17, 829	28, 360
Seventh	350, 000	300, 000	10, 084, 500	10, 734, 500	1, 020	3, 240	11, 897	16, 157
Eighth	....	....	....	20, 969, 700	....	....	11, 422	11, 422
Ninth	....	....	....	4, 131, 000	....	....	10, 789	10, 789
				40, 709, 070	20, 098	33, 897	125, 478	179, 473

D.—POPULATION LIVING AT DIFFERENT HEIGHTS.

Within municipal limits.	City proper.	Densely populated part.	Low grounds.	Medium levels.	Heights.		
					Corporate limits.	City proper.	Densely populated part.
206, 700	179, 473	136, 455	20, 098	33, 897	152, 705	125, 478	82, 460
Percentage of population in heights					73. 87	69. 91	60. 43

Havana, October, 1879.

ANTONIO ARIZA,
ANTONIO GONZÁLEZ Y HERRERA,
City Engineers.

TABLE No. 22.

A.—PEOPLE INHABITING ONE AND TWO OR MORE STORY HOUSES.

Districts.	Wards.	Houses of two or more stories.				One story.	Totals.	Percentage of two or more story houses.	People living in—			Percentage in two or more stories.
		1st story.	2d story.	3d story.	Totals.				One story houses.	Two or more stories.	Total.	
First	Templete	83	22	4	109	67	176	61. 92				
	San Felipe	89	19	2	110	203	313	35. 14				
	Santo Cristo	81	14	1	96	300	396	24. 24	12, 930	4, 310	17, 240	25.
	San Juan de Dios	81	11	7	89	212	301	29. 56				
	Santo Angel	80	5	2	97	340	427	20. 37				
		414	71	16	491	1, 122	1, 613	30. 44	....	....	....	....
Second	San Francisco	75	16	1	92	102	194	47. 57				
	Santa Clara	86	21	2	109	252	361	30. 19				
	Santa Teresa	61	17	5	83	384	467	17. 75	19, 020	3, 620	22, 640	16.
	Paula	46	22	2	70	315	385	18. 44				
	San Ysidro	26	3	0	29	602	631	8. 03				
		294	79	10	383	1, 655	2, 038	18. 79	....	....	....	....

TABLE No. 22.

A.—PEOPLE INHABITING ONE AND TWO OR MORE STORY HOUSES—Continued.

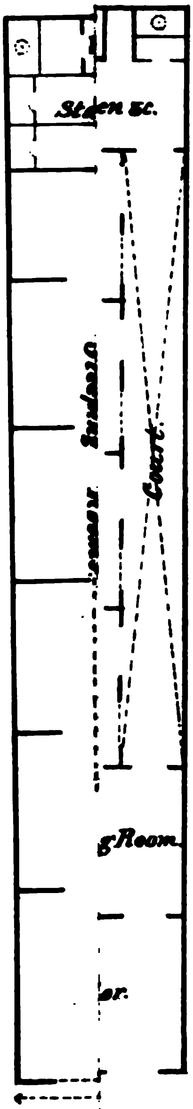
Districts.	Wards.	Houses of two or more stories. 1st story.	2d story.	3d story.	Totals.	One story.	Totals.	Percentage of two or more story houses.	People living in— One story houses.	Two or more stories.	Total.	Percentage in two or more stories.
Third........	Punta	85	2	0	87	586	673	12.93	24,060	2,670	26,730	10.
	Colon	91	3	0	94	605	699	13.45				
	Tacon	44	14	0	58	190	248	27.42				
	Marte.	40	7	0	47	440	487	9.65				
		260	26	0	286	1,821	2,107	13.57	....	......	....	......
Fourth.......	Monserrate	124	1	0	125	644	769	16.25	24,910	2,160	27,070	8.
	Dragones	36	0	0	36	318	454	7.93				
	Guadalupe	68	1	0	69	142	611	11.29				
	San Leopoldo	51	0	0	51	582	633	8.06				
		279	2	0	281	1,676	2,467	11.31	....	......	....	......
Fifth.........	Arsenal	30	0	1	31	506	537	5.78	18,785	280	19,065	1.5
	Seiba	33	5	0	38	587	625	6.08				
	Jesus Maria	7	0	0	7	327	334	2.10				
	Vives	10	0	0	10	518	528	1.89				
		80	5	1	86	1,938	2,024	4.25	....	......	....	......
Sixth	San Nicolás	47	0	0	47	489	536	8.77	27,800	560	28,360	2.
	Peñalver	29	1	0	30	675	705	4.25				
	Chavez	18	0	0	18	592	610	2.95				
	Pilar	14	0	0	14	550	564	2.48				
	Atarés	5	0	0	5	249	254	2.00				
		113	1	0	114	2,555	2,669	4.27				
Seventh	San Lázaro	12	0	0	12	387	399	3.00	15,997	160	16,157	1.
	Pueblo-Nuevo	20	0	0	20	443	463	4.32				
	Principe	4	0	0	4	122	126	1.38				
	Vedado	11	2	0	13	203	216	6.16				
		47	2	0	49	1,155	1,204	4.07				
Eighth	Jesus del Monte .	7	0	0	7	971	978	0.72	11,422	......	11,422	......
	Luyanó	3	0	0	3	101	104	2.88				
	Arroyo-Apolo	4	0	0	4	261	265	1.51				
		14	0	0	14	1,333	1,347	1.04				
Ninth........	Villanueva	17	0	0	17	272	289	5.88	10,789	......	10,789	......
	Cerro	44	0	0	44	708	752	5.82				
		61	0	0	61	980	1,041	5.86				

B.—RÉSUMÉ.

One-story houses	**14,745**
Two or more story houses	**1,765**
Total	**16,510**
People living in one-story houses	**165,713**
People living in two or more story houses	**13,760**
Total	**179,473**
Percentage of two or more story houses	**10.69**
Percentage of people living therein	**7.73**

Table No. 23

C.



	Sq. Meters
Parlor and Dining Rooms	54.00
Sleeping Rooms	74.00
Courts	39.00
Kitchen &c.	27.00
	194.00

4428 CONG

C.

Remarks.—Adding the houses (all one-story) in Puentes-Grandes, Arroyo-Naranjo, Calvario, and Casa-Blanca, the following would obtain:

One-story houses	15,494
Two or more story houses	1,765
Total	17,259
People in one-story houses	172,940
People in two or more story houses	13,760
Total	186,700
Percentage of two or more story houses	10.22
Percentage of people living therein	7.32

Havana, November, 1879.

ANTONIO ARIZA,
ANTONIO GONZÁLEZ Y HERRERA,
City Engineers.

Table No. 24.—*Bay or harbor of Havana.*

	Parts of bay.	Surfaces.		Volumes.	
		Square meters.	Totals.	Cubic meters.	Totals.
Shoals	Regla	50,000		47,000	
	Atocha	7,080		6,000	
	Feliciano	9,800		18,300	
	Cruz	49,000		27,500	
	San Telmo	65,520		161,200	
	Sunken ships	8,500	189,900	8,400	268,400
Anchorage ground	Wharves	8,700 2,800 5,850			
	Private piers, floating dock, and arsenal	52,000	69,350		
Entrance to bay		480,000		6,816,000	
Total of bay		5,520,000	6,000,000	30,000,000	36,816,000
Creeks emptying into bay. Rivers ditto	Triscornia, Marimelena, Matadero, Agua-Dulce. Martin-Perez, Luyanó.			*50,000	
Yearly mud deposit in bay.				*100,000	

* Estimated.

Remarks.—Ordinary tides, 0.70 m.; spring tides, 0.95 m.

The wharves, on account of their mode of construction, facilitate the accumulation of deposits underneath.

Engineers in Havana are of the opinion that a canal connecting the sea with the head of the bay would aid little or nothing in cleansing its waters or scouring its bottom, or in improving the sanitary conditions of the harbor.

ARIZA and HERRERA,
City Engineers of Havana.

CHAPTER XXIV.

VITAL STATISTICS OF HAVANA—POPULATION AND MORTALITY.

POPULATION.

Cuba was discovered by Columbus in 1492; the harbor of Havana was first visited by Europeans in 1508; the island was conquered by Velasquez in 1511; a settlement was made in 1515 at Chorrera or Carmelo, now a suburban ward of Havana, and the intramural "old city of Havana," finally founded in 1519, became, instead of Santiago de Cuba, the seat of government in 1552, and a "city" in 1592.

De La Torres' "Ancient and Modern Habana" states that the population in 1544 was about 520, and in 1598 was about 4,000. Pezuela's Dict., v. iii, p. 349, states that in 1600 the population was about 3,000, and in 1700 about 9,000.

The first census of Cuba was taken in 1774, when the total population of the island was 171,620; and of these about 75,000 were in the jurisdiction of Havana, which embraces an extensive district around the city. In 1792 Pezuela (*loc. cit.*) reports that the population of the city was 51,307, which is probably the first reliable statement now obtainable.

The following data sufficiently indicates the succeeding growth of the city:

TABLE No. 25.

Population in—	
1792*	51,307
1820	83,754
1827	92,229 or 94,023
1846 (official census)†	106,968
1855	153,084
1862 (exclusive of troops, &c.; census)	190,315
1877 (exclusive of troops, &c.; census)	195,437

Inasmuch as the mortality statistics are unreliable except for recent years, and do not until 1869, when Dr. A. G. Del Valle began his valuable though voluntary annual reports, contain any data as to the deaths by sex, race, age, diseases, &c., it will be unnecessary to record any of the corresponding data as to the population, except from the censuses of 1862 and 1877.

Discrepancies, omissions, &c., in the following table are due to defects in the original official reports.

TABLE No. 26.—*Civil population of the city of Havana.*

	Census year 1862.	Census year 1877.
Total population:		
Males	105,170	115,278
Females	85,145	80,159
Aggregate	*190,315	†195,437
White population:		
Males	68,216	90,006
Females	49,686	52,069
Total	117,902	142,075
Spanish and Cuban:		
Males	65,633	88,167
Females	48,508	50,937
Total	114,141	139,104
Spanish:		
Males	26,084	....
Females	6,491	....
Total	32,525	....
Cuban:		
Males	39,599	....
Females	42,017	....
Total	81,616	....
Foreigners:		
Males	2,583	1,839
Females	1,178	1,132
Total	3,761	2,971
Asiatics:		
Males	....	5,675
Females	....	48
Total	4 973	5,723
Colored:		
Males	31,981	19,597
Females	35,459	28,042
Total	67,440	47,639

* The population is also given by census of 1862 as 190,332.

† Different "official" reports give the population of Havana in 1877 "205,934," "206,104," and "206,767," and 195,437, as above, which correctly represents the civil population which corresponds with the deaths of civilians in the *city* of Havana. The municipality, the jurisdiction, and the Province of Habana have each a successively larger population, that of the Province amounting to 423,543.

* Humboldt says the population, including Regla, was 44,337 in 1791.

† Or 129,994 if the following 23,026 population be included, viz: Regla, 6,662; Casa Blanca, 996; Horcon, 6,282; Cerro, 3,459; Jesus del Monte, 4,112; Luyano, 993; Guasabacoa, 522.

Population by ages, 1862.

0 to 10 years	24,906	80 to 100 years	1,892
10 to 40 years	129,300	Over 100 years	40
40 to 60 years	26,201		
60 to 80 years	7,976	Total	190,315

TABLE No. 27.—*Number of civilians (excluding passengers in transit) arriving at and departing from the port of Havana during the 10 years,* 1870–1879; *compiled from reports furnished by the office of the United States consul-general, Mr. H. C. Hall, and derived from the daily reports published in the Havana Diario de la Marina.*

	1870.		1871.		1872.		1873.		1874.	
	In.	Out.	In.	Out.	In.	Out.	In.	Out.	In.	Out.
January	1,112	195	2,012	466	2,000	499	2,080	669	2,274	549
February	1,113	281	1,161	202	1,773	691	1,562	614	1,619	491
March	875	593	1,715	764	1,689	911	2,295	858	957	956
April	1,930	883	1,360	1,024	1,155	1,881	1,656	1,319	719	1,081
May	933	569	1,320	691	744	779	1,375	1,738	620	1,489
June	1,080	870	610	1,037	1,364	855	1,072	1,095	780	957
July	927	722	613	617	918	792	1,108	711	619	792
August	841	588	1,005	506	1,214	747	991	548	514	573
September	1,060	427	1,004	530	1,056	606	948	385	950	494
October	1,872	287	1,052	(*)	3,041	951	2,254	344	995	329
November	2,165	275	3,531	862	2,708	490	3,029	(*)	1,787	686
December	2,742	380	2,600	587	3,081	317	3,226	590	2,269	438
Totals	16,650	6,070	17,983	*7,210	20,743	9,519	21,596	*8,592	14,103	8,835
In addition: Chinese Coolies	1,249	....	1,228	....	7,590	....	4,927	....	2,512	....
Totals	17,899	6,070	19,211	7,210	28,333	9,519	26,523	8,592	16,615	8,835

	1875.		1876.		1877.		1878.		1879.		Totals.	
	In.	Out.	In.	Out.	In.	Out.	In.	Out.	In.	Out.	In.	Out.
January	1,310	529	1,942	540	3,187	921	3,276	537	2,668	234	21,861	5,139
February	1,269	598	2,944	608	1,567	771	2,100	648	1,986	887	17,094	5,791
March	1,874	1,171	1,728	1,173	2,093	810	2,797	799	1,189	1,094	17,212	9,129
April	1,694	1,267	1,652	1,127	1,471	1,359	1,873	1,045	2,342	1,137	15,852	12,123
May	1,093	1,684	1,177	1,407	930	2,041	2,110	1,246	896	1,296	11,198	12,940
June	1,278	2,021	1,071	1,454	1,632	1,618	2,715	1,144	651	1,654	12,253	12,705
July	1,536	1,169	663	1,189	1,444	1,239	2,543	1,141	981	1,521	11,352	9,893
August	1,169	783	1,034	937	769	1,118	2,426	1,420	987	1,313	10,950	8,533
September	1,165	654	1,274	590	1,968	560	2,301	833	3,084	1,414	14,810	6,493
October	2,394	176	1,932	475	2,667	387	2,651	478	1,111	386	19,969	3,813
November	1,672	461	5,018	694	3,746	489	4,004	593	1,545	509	29,205	5,059
December	2,633	616	4,347	808	3,058	582	3,934	266	2,735	1,420	30,625	6,004
Totals	19,087	11,129	24,782	11,002	24,532	11,895	32,730	10,150	20,175	12,865	212,381	97,622
In addition: Chinese coolies	......	......	......	......	......	......	......	......	......	......	17,506	......
Totals	19,087	11,129	24,782	11,002	24,532	11,895	32,730	10,150	20,175	12,865	229,887	97,622

* These sum totals do not accord in every instance with the addition of the corresponding columns because of the omissions in the blank spaces.

TABLE No. 28.—*Number of Spanish soldiers arriving at and departing from the port of Havana during the* 10 *years*, 1870–1879; *compiled from reports furnished by the office of the United States consul-general, Mr. H. C. Hall, and derived from the daily reports published in the Havana Diario de la Marina.*

	1870.		1871.		1872.		1873.		1874.	
	In.	Out.	In.	Out.	In.	Out.	In.	Out.	In.	Out.
January	536	113	2,146	219	2,836	296	1,756	383	198	215
February	....	72	528	220	713	310	2,203	135	1,091	182
March	....	119	2,056	99	1,463	472	1,277	332	475	563
April	....	50	452	231	2,079	373	749	259	346	697
May	....	76	1,132	199	1,330	485	2,029	117	104	263
June	....	139	191	358	37	526	491	600	335	276
July	....	174	40	80	22	879	286	980	37	280
August	....	136	21	232	9	381	95	347	9	167
September	492	50	32	290	....	510	1,086	90	122	208
October	3,538	217	4,432	287	38	143	745	225	1,987	322
November	2,553	153	1,716	261	84	174	1,268	211	1,653	363
December	4,164	146	3,246	273	717	553	932	240	1,801	144
Totals	11,283	1,445	15,992	2,749	9,328	5,102	12,917	3,919	8,158	3,680

	1875.		1876.		1877.		1878.		1879.		Totals.	
	In.	Out.	In.	Out.	In.	Out.	In.	Out.	In.	Out.	In.	Out.
January	2,248	247	3,501	400	688	1,320	69	746	1,750	2,060	15,728	5,999
February	1,858	205	1,986	410	992	831	34	818	1,951	1,041	11,356	4,224
March	999	521	1,785	314	799	237	11	1,142	2,030	467	10,895	4,266
April	2,601	368	2,555	379	722	763	644	702	1,354	2,580	11,502	6,402
May	1,022	801	2,105	315	657	1,263	33	568	295	520	8,707	4,607
June	1,542	217	1,806	458	79	967	31	937	295	426	4,807	4,904
July	549	285	813	400	17	796	3	2,106	....	714	1,767	6,694
August	221	289	25	395	8	477	3	2,704	4	515	395	5,643
September	1,082	452	44	426	3,158	1,506	15	3,213	7,833	346	13,864	7,091
October	7,101	182	5,999	518	1,827	598	966	1,250	224	660	26,857	4,402
November	4,099	565	10,657	539	744	617	1,349	648	1,008	868	25,131	4,399
December	4,627	419	4,014	1,182	641	882	1,733	3,058	1,539	926	23,414	7,823
Totals	27,949	4,551	35,290	5,736	10,332	10,257	4,891	17,892	18,283	11,123	154,423	66,454

MORTALITY.

In 1806 the cemetery of Espada was opened, and not until then was the pernicious practice of burying in the churches suppressed. The earliest procurable data as to the number of deaths in Havana date from 1806, and the following facts are due to Dr. Del Valle, p. 25, Ann. Rep., 1871:

In the cemetery of Espada, apparently the only one, there were buried during the fourteen years, February 2, 1806, to December 31, 1819, 46,147 dead bodies; an annual average of 3,300.

In 1820 there were 5,033 burials, and 4,666 in 1821, which give an average death-rate for these two years of about 58 to every 1,000 of the population of 1820. This is the earliest death-rate, in anywise reliable, now to be procured; and the value of this, as for many subsequent years, is impaired by doubts whether the reported deaths strictly correspond to the reported population, whether soldiers were included in the one and excluded from the other, &c.

During the eight years, 1822–1829, there were 35,188 burials; that is, an annual average of about 4,400 deaths. This would give a death-rate of about 47 to every 1,000 of the population of 1827.

For five of the preceding years, Thrasher's Humboldt, p. 115, gives the following statistics of deaths and births:

TABLE No. 29.

Years.	Deaths.	Births.
1813	2,948	3,525
1814	3,622	3,470
1820	4,833	4,495
1821	4,466	4,326
1824	6,697	3,566
Totals for five years	22,566	19,382

TABLE No. 30.—*Annual deaths in Havana*, 1830–1869.

1830	4,505	1844	5,449	1858	5,910
1831	4,594	1845	4,713	1859	5,076
1832	4,737	1846	4,355	1860	‡6,315
1833	*10,145	1847	5,298	1861	8,939
1834	5,731	1848	4,214	1862	7,685
1835	5,440	1849	4,611	1863	6,972
1836	5,569	1850	†3,666	1864	7,495
1837	4,725	1851	†5,252	1865	7,326
1838	4,447	1852	†7,252	1866	7,330
1839	4,737	1853	‡5,055	1867	§9,086
1840	4,781	1854	4,482	1868	§10,084
1841	4,912	1855	4,625	1869	7,659
1842	4,496	1856	4,353		
1843	4,702	1857	5,412		

* Of these there were 5,686 deaths by cholera.

† Cholera prevailed May 1, 1850, to February 14, 1851, and during this time there were buried 5,166 bodies in the provisional cemetery of Atares, where 722 other bodies were also buried in November and December, 1852. Thus the deaths in the two years, 1850 and 1851, were 14,084, instead of 8,918, as above stated; and for 1852, 7,974 instead of 7,252. Cholera was epidemic during these and also during subsequent years, being reported as follows, by Sala and Cortés. from "official documents": 8,215 deaths in 1850, 1,679 in 1851, 2,483 in 1852, 1,391 in 1853, 16 in 1854, 691 in 1855, and 12 in 1856.

‡ In 1853 there were 1,250 deaths by yellow fever, 1,028 in the civil and 222 in the military population. In 1860 there were 384 deaths by yellow fever; in 1861, 916.

§ Sala and Cortés reported 2,438 deaths by cholera in 1867–'68. In 1870 there were 1,655. No report has been found of the number in 1869.

TABLE No. 31.—*Annual deaths in Havana*, 1870–'79.

Year.	Deaths by all diseases in the military and civil population.	Deaths by all diseases in the civil population.*	Deaths by— Yellow fever. Military and civil population.	Yellow fever. Civil population.*	Small-pox. Military and civil population.	Cholera. Military and civil population.
1870	10,379	9,451	665	277	681	1,655
1871	9,174	8,290	901	796	1,126	....
1872	7,031	6,036	515	372	174	....
1873	7,755	6,932	1,244	1,019	47	....
1874	9,604	8,523	1,425	1,236	772	....
1875	8,390	7,044	1,001	*94	711	....
1876	9,122	7,438	1,619	904	160	....
1877	10,217	7,139	1,374	567	97	....
1878	11,507	8,594	1,559	758	1,225	....
1879	9,052	7,826	1,444	737	523	....
Totals	92,231	77,273	11,837	6,760	5,516	1,655

N. B.—The death-rate of the civil population for the five years, 1875–'79, was 39; the maximum, 44, in 1878.

* The deaths in the civil population were obtained by deducting from the total deaths the deaths of soldiers, &c., reported by the military hospitals. The latter deaths are stated differently by Dr. Del Valle and by the military hospitals; but Dr. Del Valle's figures have been accepted, except for the years unreported by him, viz, 1870 for the total deaths and 1870–'75 for deaths by yellow fever. The military hospital report yields only 94 deaths by yellow fever in 1875 for the civil population—a number too small to be credible.

Still-births.

These constitute an additional item of mortality, and varied during the past four years from 187 in 1876 to 219 in 1879.

Deaths and births in the civil population, three years, 1876–'78.

The annual average deaths were 7,724, and the births 4,967, distributed as follows:

TABLE No. 32.

Years.	Deaths.			Births.		
	Total.	White.	Colored.	Total.	White.	Colored.
1876	7,438	5,290	2,148	4,895	3,562	1,333
1877	7,139	4,986	2,153	5,030	3,653	1,377
1878	8,594	5,996	2,598	4,975	3,665	1,310
Totals	23,171	....	....	14,900	....	....
Annual average	7,724	....	....	4,967	....	....

Only the following data are procurable on which to base any estimate of the procreative power of the females in connection with the above statistics of birth.

TABLE No. 33.—*Female population of Havana.*

Years.	All ages.			16 to 40 years old.		
	Total.	White.	Colored.	Total.	White.	Colored.
1862	85,145	49,686	35,459	39,944	23,632	16,312
1877	80,159	52,069	28,090	(*)	(*)	(*)

* Unpublished.

TABLE No. 34—*Annual deaths for the* 10 *years* 1870–'79, *by race, sex, age—Civil population.*

Year.	Race.			Sex.		Age.		Sum total.
	Whites.	Colored.	Chinese.	Males.	Females.	Over 7 years.	Under 7 years.	
1870	5,528	3,509	414	6,743	2,708	6,563	2,888	9,451
1871	5,058	2,812	420	5,162	3,128	5,580	2,710	8,290
1872	3,536	2,145	355	3,718	2,318	4,367	1,669	6,036
1873	4,318	2,014	600	4,604	2,328	5,136	1,796	6,932
1874	5,426	2,559	538	5,307	3,216	5,636	2,887	8,523
1875	4,537	2,241	266	4,354	2,690	4,784	2,260	7,044
1876	4,896	2,148	394	4,667	2,771	5,438	2,000	7,438
1877	4,694	2,153	292	4,372	2,767	4,923	2,216	7,139
1878	5,710	2,598	286	5,308	3,286	5,545	3,049	8,594
1879	5,261	2,256	309	4,743	3,083	5,451	2,375	7,826
Annual average death-rate for the five years 1875–'79	35.3	47.8	54.1	40.6	36.4	....	....	39.0

The above table requires two explanations:

First. The original reports give the above data for the civil and military population consolidated, and the above figures have been obtained by deducting from each of the four columns, "race, whites," "sex, males," "age, over seven years," and "sum total" the annual deaths in the military population, viz: 928 in 1870, reported by the military hospitals; and the following reported by Dr. Del Valle: 884 in 1871, 995 in 1872, 823 in 1873, 1,081 in 1874, 1,346 in 1875, 1,684 in 1876, 3,078 in 1877, 2,913 in 1878, and 1,226 in 1879.

Second. The mortality reports give no data in reference to that most important sub-

ject, deaths by ages, except as to the ecclesiastical division—over and under 7 years of age—and since there are no corresponding data as to the population no death-rates can be calculated, and the scanty information given becomes comparatively worthless.

Only one other item as to deaths by ages has been found, viz, the deaths of persons over 85 years of age during the 5 years 1872–'76. The annual average was only 13.2 persons, distributed as follows: 7.4 whites plus 5.8 colored; and 3. males plus 10.2 females.

TABLE No. 35.—*Mortality, by months, of the total civil and military population for the* 10 *years* 1870–'79.

Years.	January.	February.	March.	April.	May.	June.	July.	August	September.	October.	November.	December.	Annual totals.
1870	553	580	635	607	642	871	1,094	988	1,860	1,273	644	632	10,379
1871	697	659	838	891	848	946	884	864	708	651	551	637	9,174
1872	583	542	638	504	582	581	554	629	600	576	566	676	7,031
1873	590	516	599	529	706	942	1,001	664	498	501	554	655	7,755
1874	639	585	710	692	806	870	1,228	1,323	836	697	621	597	9,604
1875	641	643	703	691	683	754	828	732	691	696	611	717	8,390
1876	624	569	660	631	740	961	1,384	857	700	646	637	713	9,122
1877	686	609	686	607	615	819	1,080	1,164	1,094	1,021	936	900	10,217
1878	922	857	1,040	965	1,013	1,057	1,386	1,187	934	809	634	703	11,507
1879	670	632	735	761	750	887	1,151	1,029	773	577	588	499	9,052
Average for 10 years	660	619	724	688	739	869	1,059	944	869	745	634	673	9,223
Annual average of military population	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,496
Annual average of civil population	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,727

TABLE No. 36.—*Monthly mortality by yellow fever of the civil and military population for the four years* 1853, 1860, 1861, 1864, *and the ten years* 1870–'79.

Years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual totals. Civil and military population.	Annual totals. Civil population.	Annual totals. Military population.
1853*	9	0	0	0	11	52	84	97	121	89	86	26	769	575	194
1854*	8	7	12	22	47	164	290	242	155	62	10	9	1,284	1,028	256
1860†	4	3	3	7	4	25	74	122	106	28	4	4	384	.....	.....
1861†	4	4	4	39	45	179	211	140	63	118	109	0	916	.....	.....
1864‡	42	16	29	1	17	48	80	133	94	27	50	18	555	.....	.....
1870§	6	4	4	6	14	66	112	201	91	77	49	35	665	.....	388
1871	18	23	12	54	91	201	234	138	72	55	51	42	991	.....	195
1872	20	13	4	4	13	68	68	70	50	38	85	73	515	.....	143
1873	32	23	27	37	127	378	416	127	35	28	5	9	1,244	.....	225
1874	7	4	18	22	85	172	361	416	186	91	42	21	1,425	.....	189
1875	16	16	32	34	32	142	187	144	102	109	105	82	1,001	.....	907?
1876	24	24	29	33	103	292	675	250	97	42	31	19	1,619	904	715
1877	8	9	11	8	16	143	249	285	234	185	150	76	1,374	567	807
1878	26	13	5	28	53	184	504	374	179	106	53	34	1,559	758	801
1879	11	13	6	13	40	237	475	417	148	44	31	9	1,444	737	707
Averages for the ten years	17	14	15	24	57	188	328	242	120	78	60	40	1,184	.....	.....

* Peñuela's Topg. Med., pp. 154, 158. The monthly deaths are for the *civil population only*.

† Pp. 51, 52, v. 6, Anales de la Academia, &c., Habana.

‡ Pp. 80, 344, v. 1, of Anales.

§ Dr. A. G. Del Valle's An. Reports supply all these data for 1870–'79, except the deaths by yellow fever in the military population 1870–'75, which were derived from the Military Hospital Reports.

Deaths by consumption.

Since the deaths by this disease are more numerous than by any other disease, the following scanty data, all reported except those recorded in the succeeding tables of "Deaths by diseases," deserve record.

TABLE No. 37.—*Deaths by phthisis, for sex and age, in* 1876.

Year.	Males over 7 years.	Females over 7 years.	Males under 7 years.	Females under 7 years.	Total.
1876	991	605	61	57	1,714

N. B.—The maximum monthly deaths were 160 in December; the minimum, 126 in June.

Deaths by phthisis, for race and season, in* 1877.

Race.	Winter.*	Spring.	Summer.	Fall.	Totals.
White	332	292	314	313	1,251
Colored	134	119	114	129	496
Totals	466	411	428	442	1,747

*In Cuban statistics winter consists always of January, February, and March, and the succeeding seasons of the succeeding series of three months.

Deaths by diseases.

The three following tables furnish all the facts procurable on this subject. The first is the most valuable of the three, but in this the number of diseases specified is so few and the number of deaths give so unsatisfactory an idea of the number of cases of sickness, that the second and third tables have been added to throw as much light as could be obtained on these two subjects.

TABLE No. 38.—*Deaths by diseases in the civil and military population of Havana during the nine years 1871–'79, compiled from the annual reports of Dr. A. G. Del Valle.*

Diseases.	Total deaths in 1871.	Total deaths in 1872.	Total deaths in 1873.	Total deaths in 1874.	Total deaths in 1875.	Total deaths in 1876.	Total deaths in 1877.	Total deaths in 1878.	Total deaths in 1879.	1871.			
										Winter.	Spring.	Summer.	Fall.
Alcoholismus								53	51				
Anthrax							2	4					
Beriberi						12	5	0	3				
Cholera, sporadic	52	7	54	7	1	4	5	0		0	1	4	37
Cholera, infantum	53	32	78	170	134	156	189	194	218	12	29	5	7
Diarrhœa		355	184	270	344	389	1,042	1,167	362				
Dysentery	125	160	134	145	115	147	238	181	130	37	10	35	43
Diphtheria	61	52	23	23	44	41	42	48	38	14	21	11	15
Eclampsia, infantum	39	39	50	62	42	54	50	62	51	2	19	10	8
Erysipelas								22	18				
Farcy		0	2	9	4	11	12	7	10				
Fever, bilious	34	36	34	33	33	43	63	37	44	0	9	9	26
Fever, paludean	218	280	295	255	251	291	359	416	299	0	58	83	77
Fever, typhoid		150	159	167	144	162	211	155	150				
Fever, yellow	991	515	1,244	1,425	1,001	1,619	1,374	1,559	1,444	53	346	444	148
Heart disease								243	275				
Hepatic disease							238	278	253				
Hooping-cough		0	0	24	2	2	14	18	8				
Hydrophobia		0	3	3	1	1	0	1	4				
Measles		4	0	46	4	10	0	28					
Meningitis		207	272	387	307	273	290	292	301				
Parturition, puerperal fever, &c		18	28	25	25	43	38	25	31				
Pemphigus							2	2	3				
Phthisis pulmonalis		1,415	1,339	1,467	1,466	1,714	1,747	1,714	1,733				
Pneumonia	137	239	235	316	246	302	268	283	294	2	17	61	57
Scarlet fever		2	1	1	6	6	3	5	3				
Small-pox	1.126	174	47	772	711	160	97	1,225	523	387	631	86	22
Tetanus	45	45	42	38	47	55	58	45	48	12	17	4	12
Trismus nascentium	377	388	368	389	388	408	407	427	328	77	80	95	125
Homicide								55					
Suicide								22					
Sudden death		64	41	59	58	48	45	84	74				
Senility		9	13	16	17	14	9	9	25				
All other diseases	5,916	2,840	3,100	3,496	3,004	3,157	3,414	2,857	2,331	1,598	1,447	1,609	1,262
Totals	9,174	7,031	7,755	9,604	8,390	9,122	10,217	11,507	9,052	2,194	2,685	2,456	1,839
Totals for the year										9,174			

N. B.—Winter consists of January, February, and March.

TABLE No. 38.—*Deaths by diseases in the civil and military population of Havana during the nine years 1871-'79, &c.*—Continued.

Diseases.	1872.				1873.				1874.				1875.			
	Winter.	Spring.	Summer.	Fall.	Winter.	Spring.	Summer.	Fall.	Winter.	Spring.	Summer.	Fall.	Winter.	Spring.	Summer.	Fall.
Alcoholismus	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Anthrax	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Beriberi	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Cholera, sporadic	7	0	0	0	39	4	11	0	0	0	6	1	0	0	1	0
Cholera infantum	2	14	8	8	12	18	23	25	35	28	94	13	39	83	85	27
Diarrhœa	76	75	84	120	91	35	29	29	49	57	94	70	62	87	94	101
Dysentery	42	30	55	33	41	21	31	41	46	26	41	32	28	22	47	18
Diphtheria	12	17	12	11	10	6	3	4	2	9	3	9	12	9	7	16
Eclampsia, infantum	10	8	11	10	18	19	13	14	14	13	24	11	13	12	9	8
Erysipelas	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Farcy	......	......	......	......	0	0	1	1	2	2	3	2	2	1	0	1
Fever, bilious	4	7	8	17	7	7	10	10	4	5	15	9	6	6	12	9
Fever, paludean	59	63	85	73	71	77	91	56	48	55	83	69	49	60	81	61
Fever, typhoid	30	35	38	47	35	44	48	32	25	42	66	34	33	31	41	39
Fever, yellow	37	85	197	196	82	542	578	42	29	279	963	154	64	208	433	296
Heart disease	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Hepatic disease	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Hooping-cough	......	......	......	......	0	0	0	0	13	11	0	0	1	0	0	1
Hydrophobia	......	......	......	......	1	1	1	0	2	0	1	0	0	1	0	0
Measles	1	2	0	1	0	0	0	0	17	21	8	0	0	2	2	0
Meningitis	32	74	61	40	54	88	71	59	86	126	127	48	79	72	95	61
Parturition, puerperal fever, &c	4	4	7	3	7	3	9	9	7	6	7	5	3	2	7	13
Pemphigus	1	2	......	1	......	......	......	......	......	......	......	......	......	......	......	......
Phthisis pulmonalis	376	343	326	370	350	355	310	324	353	354	402	358	396	335	346	389
Pneumonia	81	67	40	51	65	67	55	48	95	86	68	67	70	58	57	61
Scarlet fever	......	1	......	1	0	1	0	0	1	0	0	0	0	2	2	2
Small-pox	63	81	18	12	10	17	11	9	31	228	293	160	240	353	97	21
Tetanus	15	11	10	9	8	9	11	14	10	5	12	11	13	14	11	9
Trismus nascentium	100	77	88	123	97	92	82	97	83	93	117	96	87	77	116	108
Homicide	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Suicide	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Sudden death	16	18	15	15	9	9	14	9	13	15	13	18	16	14	7	16
Senility	3	2	3	1	3	3	5	2	4	5	3	4	2	4	4	7
All other diseases	793	653	717	677	700	759	756	885	965	842	944	744	772	725	747	760
Totals	1,763	1,667	1,783	1,818	1,705	2,177	2,163	1,710	1,934	2,368	3,387	1,915	1,987	2,128	2,251	2,024
Totals for the year	7,031				7,755				9,604				8,390			

TABLE No. 38.—*Deaths by diseases in the civil and military population of Havana during the nine years* 1871-'79, *&c.*—Continued.

Diseases.	1876.				1877.				1878.				1879.			
	Winter.	Spring.	Summer.	Fall.	Winter.	Spring.	Summer.	Fall.	Winter.	Spring.	Summer.	Fall.	Winter.	Spring.	Summer.	Fall.
Alcoholismus	...	...	...	...	...	...	...	...	11	13	17	11	13	16	11	12
Anthrax	...	...	...	...	0	1	1	0	2	2	0	0	...	...	...	...
Beriberi	0	0	0	12	1	0	4	0	0	0	0	0	1	2	0	0
Cholera, sporadic	0	0	1	3	2	2	0	1	0	0	0	0	0	1	...	...
Cholera infantum	43	64	35	14	53	55	60	21	38	66	57	33	45	77	65	81
Diarrhœa	70	94	93	132	108	103	377	454	332	233	360	242	116	89	63	184
Dysentery	41	37	31	46	47	45	69	77	40	47	58	41	42	25	31	82
Diphtheria	13	13	7	8	10	13	5	14	12	11	10	15	13	13	6	6
Eclampsia infantum	18	14	10	12	13	9	11	17	18	18	22	9	8	18	19	6
Erysipelas	...	...	...	...	...	...	...	...	8	7	4	3	6	4	5	3
Farcy	2	1	3	5	1	2	7	2	0	0	4	3	2	2	4	2
Fever, bilious	6	9	17	11	11	13	18	21	8	5	18	6	3	6	21	14
Fever, paludean	63	79	87	62	58	78	129	94	76	108	153	79	44	60	125	70
Fever, typhoid	36	45	50	31	30	46	90	45	31	37	58	34	23	45	47	35
Fever, yellow	77	428	1,022	93	28	167	768	411	44	265	1,057	193	30	290	1,040	84
Heart disease	...	...	...	...	...	...	...	...	65	71	60	47	60	68	55	92
Hepatic disease	...	...	...	...	55	58	55	70	76	65	76	56	80	47	55	71
Hooping cough	0	0	0	2	3	5	2	4	4	6	2	1	2	2	3	1
Hydrophobia	1	0	0	0	0	0	0	0	0	1	0	0	...	...	3	1
Measles	5	2	1	2	0	0	0	0	9	15	8	1	...	...	...	...
Meningitis	61	77	87	48	68	80	94	48	65	106	77	44	64	77	110	50
Parturition, puerperal fever, &c	13	7	11	12	10	10	10	8	7	9	4	5	5	11	9	6
Pemphigus	...	...	...	...	0	0	2	0	1	1	0	0	0	1	1	1
Phthisis pulmonalis	428	390	439	448	466	411	428	442	465	443	412	394	476	425	410	422
Pneumonia	88	66	69	79	61	75	79	58	88	87	51	57	92	64	64	74
Scarlet fever	2	2	2	0	2	1	0	0	0	4	0	1	1	1	1	0
Small-pox	41	98	14	7	12	14	23	48	490	549	119	67	150	285	73	15
Tetanus	14	13	11	17	12	17	11	13	13	14	9	9	13	17	10	8
Trismus, nascentium	76	100	114	118	88	102	119	103	124	82	110	111	74	87	77	90
Homicide	...	...	...	...	...	...	...	...	12	17	13	13	...	...	...	...
Suicide	...	...	...	...	...	...	...	...	4	4	5	9	...	...	...	...
Sudden death	7	9	18	14	8	8	17	12	28	14	17	25	16	16	22	20
Senility	3	4	1	6	2	1	2	4	4	1	1	3	5	5	4	11
All other diseases	745	781	816	815	837	725	957	895	749	734	740	634	653	695	620	363
Totals	1,853	2,332	2,941	1,996	1,981	2,041	3,338	2,857	2,819	3,085	3,507	2,146	2,037	2,398	2,963	1,664
Totals for the year	9,122				10,217				11,507				9,062			

ADDENDUM A TO TABLE No. 38.—*Deaths by diseases, for the year 1880.*

Diseases.	Civil and military population. Total deaths in 1880.	Deaths in 1880 in— Winter.	Spring.	Summer.	Fall.	Deaths in 1880 of— Civil population. Whites.	Asiatic.	Colored.	Military population.
Albuminuria	19	5	5	7	2	15	1	3	......
Alcoholismus	52	8	12	18	14	26	......	26	......
Anginas	4	3	1	....	....	3	......	1	......
Anthrax	1	....	....	1	....	1	......	....	......
Cholera, sporadic	2	1	....	1	....	1	......	1	......
Cholera infantum	101	28	38	26	9	74	......	27	......
Diabetes	8	....	5	....	3	4	......	4	......
Diarrhœa and enteritis	921	170	221	301	229	456	23	186	256
Dysentery	121	24	30	35	32	52	3	34	32
Diphtheria and croup	64	22	13	12	17	56	......	8	......
Eclampsia infantum	49	12	13	14	10	33	......	16	......
Epilepsy	20	4	5	5	6	8	.....	12	......
Erysipelas	9	2	1	2	4	7	......	1	1
Farcy	22	8	3	6	5	20	......	1	1
Fever, bilious	49	12	10	18	9	24	2	4	19
Fever, paludean	335	71	87	100	77	183	13	81	58
Fever, typhoid	159	35	36	52	36	92	6	44	17
Fever, yellow	892	47	232	511	102	426	......	....	466
Heart disease	353	94	91	87	81	164	15	169	5
Hepatic disease	247	50	54	80	63	162	16	63	6
Hooping cough	16	3	2	7	4	10	......	6	......
Measles	6	1	....	2	3	3	......	3	......
Meningitis	318	51	107	97	63	233	1	82	2
Other cerebral diseases, apoplexy, &c.	282	72	76	67	67	156	2	121	3
Parturition, puerperal fever, &c.	31	12	4	9	6	21	......	10	......
Peritonitis	24	6	8	3	7	13	2	8	1
Pemphigus	1	....	....	1	....	....	......	1	......
Phthisis pulmonalis	1,629	409	392	429	401	941	147	508	33
Pleurisy	4	3	1	....	....	4	......	....	......
Pneumonia and bronchitis	360	98	84	84	94	201	5	114	40
Scarlet fever	2	....	2	....	....	2	......	....	......
Small-pox	446	47	171	82	146	274	1	154	17
Tetanus	45	15	12	5	13	17	1	27	......
Trismus, nascentium	340	76	81	90	94	206	......	134	......
Senility	42	8	7	9	18	14	......	28	......
Sudden death	51	15	15	9	12	27	7	17	......
All other causes	917	199	240	240	235	517	78	251	71
Totals	7,942	1,611	2,059	2,410	1,862	4,446	323	2,140	1,033

Civil population, 195,437; deaths of civilians, 6,909; death-rate of civilians, 35.35.

A. G. DEL VALLE, *M. D.*

ADDENDUM B TO TABLE No. 38.—*Deaths, by months, for* 1880.

	Civil population.							Total deaths of military population.
	Whites.			Asiatics.	Colored.	Unknown.	Total deaths of civilians.	
	Spaniards and Canary Islanders.	Cubans.	Europeans and Americans.					
January	98	187	5	31	154	6	481	47
February	110	179	5	28	166	2	489	24
March	105	201	9	30	177	4	526	44
April	114	199	6	21	183	2	525	64
May	141	218	13	23	186	1	582	55
June	152	309	20	31	196	2	710	123
July	236	294	13	28	213	1	785	209
August	192	222	22	36	211	6	689	145
September	128	184	10	18	145	3	488	94
October	131	190	17	26	179	1	544	97
November	110	229	10	26	159	2	536	72
December	127	212	12	25	171	7	554	59
Total	1,643	2,624	142	323	2,140	37	6,909	1,033

ADDENDUM C TO TABLE No. 38.—*Deaths, by sex, age, and race, for* 1880.

	Civil population.			Military population.	Total civil and military population.
	Whites.	Colored.	Asiatic.		
Males over 7 years	2,093	638	323	1,033	4,087
Males under 7 years	764	364	......	....	1,128
Total males	2,857	1,002	323	1,033	5,215
Females over 7 years	939	792	......	....	1,731
Females under 7 years	650	346	......	....	996
Total females	1,589	1,138	......	....	2,727
Total males and females	4,446	2,140	323	1,033	7,942

N. B.—In addition to the 6,909 deaths in 1880 in the civil population, there were 176 still-births, of which 89 were white and 87 were colored.

TABLE No. 39.—*Annual report for* 1878 *of the civil hospital at Havana, viz, the "Hospital General de S. Felipe y Santiago de la Habana."*

MONTHLY SUMMARY BY DISEASES.

Diseases.	January.		February.		March.		April.		May.	
	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.
CONTAGIOUS.										
Yellow fever	6	1	2						17	4
Farcy		1								
Measles	1		3		4	1	8		10	
Small-pox	29	17	24	7	23	17	11	13	20	12
MEDICAL.										
Diseases of brain, acute		4		5	1	3	1	4	2	2
Diseases of brain, chronic	8		3		8		6	1	6	2
Diseases of spinal cord	1	1				1	4	4	3	3
Diseases of respiratory organs, acute	25	1	19	1	13	2	15	3	31	2
Diseases of respiratory organs, chronic	2	10	11	4	7	2	3		3	
Diseases, gastro-intestinal, acute	20		31	3	32		33	2	56	
Diseases, gastro-intestinal, chronic	3	10	10	8	18	7	16	8	8	10
Diseases, organic, of the heart		1		1		5	3	5	2	5
Diseases, hepatic	2	4	2	4	3	3	4	3	4	4
Alcoholismus	16	3	6	1	16	5	15	3	27	5
Anginas	2		4		3				1	
Nephritic colic										
Dyscracias	4	5	4		9		13	2	2	1
Dysentery	5	1	3			1	2		2	1
Spermatorrhea									1	1
Splenitis										
Fevers:										
Ephemeral	5		5		8		3		2	
Bilious					1	1				
Gastric	3		2		2		4		6	
Typhoid		2	2	2			2	2	3	
Paludean	8		16		14		25		27	
Pernicious		2	3	1	3	5	2	1	3	4
Catarrhal	18		11		30		22		22	
Opium poisoning	2			2		2	3	1	3	2
Nephritis										2
Neuralgia	3		2		3		2		1	
Epilepsy	1		2		1		1			
Rheumatism	27	2	33	1	23		26	1	41	
Old age	7	6	1	1	8	1		2	5	5
Tetanus				1			1	1		
Phthisis	21	34	9	30	19	29	7	25	16	35
SURGICAL.										
Diseases of the eye, acute			10	1	4		7		4	
Diseases of the eye, chronic	3				1		2		1	
Diseases of the bones	3		1	1	3		4			
Diseases of the bladder			1		2		1			
Aneurism	1		1	1						
Blenorrhagia	10		9		20		9		13	
Cancer	1			1		1	2	1	3	1
Foreign bodies in œsophagus										
Chancres and bubos	33		22		29		25		35	
Diseases of the skin	15		7		27	1	23	1	23	1
Tumors, various			2		2		1			
Scrofula	1		1		1				2	
Strictures, urethral	1	1			1		1		4	
Fractures	5		3		4	1	5		6	2
Fistulæ, urinal	2		2		2		2			
Fistulæ, anal	1									
Gangrene	1		1		2		1	1		
Wounds and contusions	56		50	1	71	1	59	5	83	1
Hematocele							1		2	
Hernia	2	2	2		2				1	
Hydrocele			3		1		2		7	
Inflammation	10		11	1	8		5		7	1
Dislocations			2		1				1	
Orchitis	4		3		8					
Burns	2		2				2		2	
Syphilis	8		14	1	19		16	2	15	1
Ulcers	49		26		31	1	42		42	
Totals	427	108	381	79	488	90	442	91	575	107

TABLE No. 39—Continued.

Diseases.	June.		July.		August.		September.		October.	
	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.
CONTAGIOUS.										
Yellow fever	15	17	48	40	23	29	10	15	8	13
Farcy			1	3		1		1	2	
Measles	4.		3		3					
Small-pox	11	9	6	7	3	2	5	3	1	4
MEDICAL.										
Diseases of brain, acute	2	4		2	2	4	3	4		4
Diseases of brain, chronic	12	1	3	2	8		2	2	9	2
Diseases of spinal cord	5		2		1	1			2	
Diseases of respiratory organs, acute	23	7	26	1	12	2	20	1	11	3
Diseases of respiratory organs, chronic	6		5		6		4	1	20	1
Diseases, gastro-intestinal, acute	50		57	4	37	4	49		31	
Diseases, gastro-intestinal, chronic	19	14	47	14	49	11	4	17	16	14
Diseases, organic, of the heart	4	3	1	3	4	3	4	3	1	6
Diseases, hepatic	5	7	5	3	3	4	8	5	7	6
Alcoholismus	14	3	17	6	13	2	22	2	13	2
Anginas	1				1		2		2	
Nephritic colic							1			
Dyscracias	5		10	4	10	1	11	1	6	3
Dysentery	3		4		5	1	4	2	5	
Spermatorrhea					1					
Splenitis					1		1		1	
Fevers:										
Ephemeral	9		12		9		3		2	
Bilious		1			1	1				
Gastric	5		21		38		18		9	
Typhoid	1		1		2		1	3		3
Paludean	20		37		41		39		96	4
Pernicious		1		5	6	2	1	3	1	6
Catarrhal	16		33		36		42		24	
Opium poisoning	1	2	4		5	1	1	1	1	4
Nephritis	1					3	1	2	1	2
Neuralgia	2		3		8		5		7	
Epilepsy			4	1			1		1	1
Rheumatism	32		30	1	24		41		13	
Old age	3	2			1	2	2	2	1	2
Tetanus		1					1	2		1
Phthisis	10	24	9	27	20	23	24	21	17	25
SURGICAL.										
Diseases of the eye, acute	1		6		8		11		11	
Diseases of the eye, chronic	2				2				1	
Diseases of the bones	5		1		2	1	1		1	
Diseases of the bladder					2		4	1	2	
Aneurism				1						
Blenorrhagia	15		11		14		6		4	
Cancer		1	1	2	2			2		1
Foreign bodies in œsophagus					1					
Chancres and bubos	34		35		39		46		39	
Diseases of the skin	14	1	19	1	16	1	18		11	
Tumors, various	5	1			1	1	4		4	
Scrofula	3		4		2		6		4	
Strictures, urethral	4		3			1	7		7	
Fractures	7	1	4	1	6		5		6	
Fistulæ, urinal	3		1		4		2		3	
Fistulæ. anal										
Gangrene										1
Wounds and contusions	76	1	72		57	2	71		91	4
Hematocele					1					
Hernia			1		2		2		1	
Hydrocele	2		7		1		6		5	
Inflammation	14	1	17	2	12	2	7		10	
Dislocations					1					
Orchitis	5		4		4		6		8	
Burns			2		2				2	
Syphilis	17		26	2	21	1	19	1	14	
Ulcers	33		41		42	1	47		55	
Totals	519	102	644	132	615	107	598	95	587	112

TABLE No. 39—Continued.

Disease.	November.		December.		Total discharged.	Total died.	Total of discharges and deaths.
	Discharged.	Died.	Discharged.	Died.			
CONTAGIOUS.							
Yellow fever	6	9	1	3	136	131	267
Farcy	....	1	....	....	3	7	10
Measles	....	....	....	....	36	1	37
Small-pox	5	2	12	4	150	97	247
MEDICAL.							
Diseases of brain, acute	....	5	1	2	12	43	55
Diseases of brain, chronic	12	....	7	....	84	10	94
Diseases of spinal cord	4	2	5	1	27	13	40
Diseases of respiratory organs, acute	26	1	13	4	234	28	262
Diseases of respiratory organs, chronic	12	1	14	....	93	19	112
Diseases, gastro-intestinal, acute	40	3	45	1	481	17	498
Diseases, gastro-intestinal, chronic	5	13	1	17	196	143	339
Diseases, organic, of the heart	2	3	1	4	22	42	64
Diseases, hepatic	7	2	6	3	56	48	104
Alcoholismus	20	3	25	6	204	41	245
Anginas	3	....	2	....	21	0	21
Nephritic colic	1	....	....	....	2	0	2
Dyscracias	8	....	15	2	97	19	116
Dysentery	3	3	....	....	36	9	45
Spermatorrhea	....	....	....	....	2	1	3
Splenitis	....	....	....	1	3	0	3
Fevers:							
Ephemeral	2	....	3	....	63	0	63
Bilious	....	....	....	....	2	3	5
Gastric	4	....	....	....	112	0	112
Typhoid	3	1	3	....	18	13	31
Paludean	48	....	48	1	419	5	424
Pernicious	....	3	1	3	20	36	56
Catarrhal	29	....	29	....	312	0	312
Opium poisoning	2	....	1	2	23	17	40
Nephritis	1	....	1	1	5	10	15
Neuralgia	3	....	2	....	41	0	41
Epilepsy	3	....	3	....	17	2	19
Rheumatism	15	....	29	....	334	5	339
Old age	1	....	11	1	40	24	64
Tetanus	....	1	....	1	2	8	10
Phthisis	8	28	8	25	168	326	494
SURGICAL.							
Diseases of the eye, acute	3	....	8	....	73	1	74
Diseases of the eye, chronic	....	....	1	....	13	0	13
Diseases of the bones	4	....	3	....	28	2	30
Diseases of the bladder	2	....	1	....	15	1	16
Aneurism	....	....	....	1	2	3	5
Blenorrhagia	9	....	11	....	131	0	131
Cancer	1	....	2	2	12	12	24
Foreign bodies in œsophagus	....	....	....	....	1	0	1
Chancres and bubos	28	1	39	....	404	1	405
Diseases of the skin	14	1	25	1	212	8	220
Tumors, various	....	....	2	....	21	2	23
Scrofula	5	....	6	1	35	1	36
Strictures, urethral	1	....	3	....	32	2	34
Fractures	3	....	7	1	61	6	67
Fistulæ, urinal	....	....	....	....	21	0	21
Fistulæ, anal	1	....	1	....	3	0	3
Gangrene	....	....	1	....	6	2	8
Wounds and contusions	65	1	81	3	832	19	851
Hematocele	....	....	....	....	4	0	4
Hernia	1	....	4	....	18	2	20
Hydrocele	4	....	2	....	40	0	40
Inflammation	6	2	7	....	114	9	123
Dislocations	....	....	1	....	6	0	6
Orchitis	4	....	3	....	49	0	49
Burns	....	....	1	....	15	0	15
Syphilis	16	....	23	....	208	8	216
Ulcers	32	....	42	....	482	2	484
Totals	472	86	561	90	6,309	1,199	7,508

TABLE No. 39—Continued.

ANNUAL SUMMARY.

Remaining 31st December, 1877	351
Admitted 1878	7,526
Discharged 1878	6,309
Died 1878	1,199
Remaining January 1, 1879	369

MONTHLY SUMMARY.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Admitted	533	493	584	532	697	653	791	732	649	677	600	585	7,526
Discharged	427	381	488	442	575	519	644	615	598	587	472	561	6,309
Died	108	79	90	91	107	102	132	107	95	112	86	90	1,199

TABLE No. 40.—*Annual report for* 1878 *of the "Quinta La Integridad Nacional" Private Infirmary, Havana.*

MONTHLY SUMMARY BY DISEASES.

Diseases.	January.		February.		March.		April.		May.	
	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.
CONTAGIOUS.										
Yellow fever		2					11	5	27	9
Farcy										
Measles									2	
Small-pox	5	1	8	3	21	10	23	6	14	2
MEDICAL.										
Diseases of brain, acute								1		1
Diseases of brain, chronic			1							
Diseases of spinal cord						1		1		
Diseases of respiratory organs, acute	17		19	1	11		13		14	
Diseases of respiratory organs, chronic	5			1	1		1			1
Diseases, gastro-intestinal, acute	11		8		7		9		17	
Diseases, gastro-intestinal, chronic	3						1			
Diseases, organic, of heart		1				1				1
Diseases, hepatic									2	
Alcoholismus	1							1		
Anginas	3		2		5		5		2	
Nephritic colic					1					
Dyscracias	2				3		3			
Dysentery	1	1								
Splenitis										
Fevers:										
Ephemeral	7		6		9		10		21	
Bilious										
Gastric	27		19		35		38		56	
Typhoid		1	2		1		3	2	4	
Pernicious					1					
Paludean	2		8		9		7		9	
Catarrhal	21		17		21		15		28	
Nephritis										
Neuralgia	2		3		3		6		6	
Rheumatism	5		4		6		7		8	
Tetanus										
Phthisis		4		3		2		1	2	3

TABLE No. 40—Continued.

Diseases.	January.		February.		March.		April.		May.	
	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.
SURGICAL.										
Diseases of the eye	1				2		2		4	
Diseases of the bones	1				1					
Aneurism										1
Blenorrhagia	9		10		13		9		12	
Cancer									1	
Chancres and bubos	10		7		6		4		10	
Tumors, various			3		5					
Scrofula			1				1			
Strictures, urethral										
Fractures					1				2	1
Fistulæ, urinal										
Fistulæ, anal									1	
Wounds and contusions	3		3		3				5	
Hematocele									1	
Hydrocele			1		1		2			
Inflammation	7	1	10		8		7		15	1
Dislocations							2			
Orchitis	2		2		3		4		4	
Boils	6		5		8		5		6	
Syphilis	5		7		4				1	
Ulcers	2		4		5		1		4	
Totals	158	11	150	8	194	14	189	17	278	20

Diseases.	June.		July.		August.		September.		October.	
	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.
CONTAGIOUS.										
Yellow fever	64	22	98	41	76	23	24	5	2	2
Farcy										
Measles	5		3							
Small-pox	6		4				1			
MEDICAL.										
Diseases of brain, acute		1								
Diseases of brain, chronic			2						1	
Diseases of spinal cord										
Diseases of respiratory organs, acute	14		17		9		11		9	
Diseases of respiratory organs, chronic		1	1	1			2			
Diseases, gastro-intestinal, acute	16		13		11		10		13	
Diseases, gastro-intestinal, chronic			2							
Diseases, organic, of heart				1				1		
Diseases, hepatic			1	1			2		1	
Alcoholismus			1			1				
Anginas	2		7		2		8		5	
Nephritic colic									1	
Dyscracias	2		5		3		5		2	
Dysentery	1				2				2	
Splenitis					1					
Fevers:										
Ephemeral	9		12		11		16		10	
Bilious				1						
Gastric	40		72		48		57		21	
Typhoid	2	1	3	1	2		1		2	1
Pernicious	1		2							
Paludean	9		8		5		7		5	
Catarrhal	11		25		19		22		24	
Nephritis					1					
Neuralgia	2		11		3		2		3	
Rheumatism	3		9		5		5		8	
Tetanus				1						
Phthisis		1	1	2		3		2		3

TABLE No. 40—Continued.

Diseases.	June.		July.		August.		September.		October.	
	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.
SURGICAL.										
Diseases of the eye			5		2		1		4	
Diseases of the bones			3							
Aneurism										
Blenorrhagia	13		18		13		11		13	
Cancer				1						
Chancres and bubos	7		11		17		12		11	
Tumors, various	6		6		2		4		5	
Scrofula			2						2	
Strictures, urethral			1		1				2	
Fractures									2	
Fistulæ, urinal										
Fistulæ, anal										
Wounds and contusions	6		7		1		5		4	
Hematocele										
Hydrocele			3						1	
Inflammation	13	2	18	1	12		9		15	
Dislocations			2						1	
Orchitis	5		4						3	
Boils	2		10		6				10	
Syphilis	6		7				8		4	
Ulcers	4		5		1		3		4	
Totals	249	28	399	51	253	27	226	8	190	6

Diseases.	November.		December.		Totals.		
	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.	Discharged and died.
CONTAGIOUS.							
Yellow fever	17	3	12	1	331	113	444
Farcy				1		1	1
Measles					10		10
Small-pox				3	82	25	107
MEDICAL.							
Diseases of brain, acute						3	3
Diseases of brain, chronic					4		4
Diseases of spinal cord		1		1		4	4
Diseases of respiratory organs, acute	8		15		157	1	158
Diseases of respiratory organs, chronic					10	4	14
Diseases, gastro-intestinal, acute	13		12		140		140
Diseases, gastro-intestinal, chronic					6		6
Diseases, organic, of heart						5	5
Diseases, hepatic					6	1	7
Alcoholismus					2	2	4
Anginas	8		8		57		57
Nephritic colic					2		2
Dyscracias	3				28		28
Dysentery	1				7	1	8
Splenitis					1		1
Fevers:							
Ephemeral	12		9		132		132
Bilious						1	1
Gastric	27		14		454		454
Typhoid	2				22	6	28
Pernicious				1	4	1	5
Paludean	14		9		92		92
Catarrhal	23		29		255		255
Nephritis					1		1
Neuralgia	4		2		47		47
Rheumatism	3		6		69		69
Tetanus						1	1
Phthisis		1		2	3	27	30

TABLE No. 40—Continued.

Diseases.	November.		December.		Totals.		
	Discharged.	Died.	Discharged.	Died.	Discharged.	Died.	Discharged and died.
SURGICAL.							
Diseases of the eye			2		23		23
Diseases of the bones					5		5
Aneurism						1	1
Blenorrhagia	9		10		140		140
Cancer					1	1	2
Chancres and bubos	7		7		109		109
Tumors, various					31		31
Scrofula					6		6
Strictures, urethal					4		4
Fractures					5	1	6
Fistulæ, urinal							
Fistulæ, anal					1		1
Wounds and contusions					37		37
Hematocele					1		1
Hydrocele					8		8
Inflammation	8		9		131	5	136
Dislocations					5		5
Orchitis					27		27
Boils	9		2		69		69
Syphilis	3		1		46		46
Ulcers	2				35		35
Totals	178	5	147	9	2,606	204	2,810

ANNUAL SUMMARY.

Remaining 31st December, 1877	62
Admitted, 1878	2,816
Discharged, 1878	2,606
Died, 1878	204
Remaining 1st January, 1879	68

MONTHLY SUMMARY.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Admitted	179	181	205	205	248	295	476	289	232	191	171	144	2,816
Discharged	158	150	194	189	278	249	399	253	226	190	173	147	2,606
Died	11	8	14	17	20	28	51	27	8	6	5	9	204

CHAPTER XXV.

VITAL STATISTICS OF THE ISLAND OF CUBA, INCLUDING THE ISLE OF PINES.

TABLE No. 41.—*Population.*

Census.	Whites.*			Colored.			White and colored.		
	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Total.
1774	55, 576	40, 864	96, 440	44, 923	30, 257	75, 180	100, 499	71, 118	171, 620
1792	72, 299	61, 254	133, 553	74, 319	66, 067	140, 386	146, 618	127, 321	273, 939
1817	149, 725	126, 964	276, 689	207, 159	151, 756	358, 915	356, 884	278, 720	635, 604
1827	168, 653	142, 398	311, 051	235, 252	158, 184	393, 436	403, 905	300, 582	704, 487
1841 †	227, 144	191, 147	418, 291	356, 953	232, 280	589, 333	584, 097	423, 527	†1, 007, 624
1846	230, 985	194, 784	425, 769	273, 662	199, 323	472, 985	504, 647	394, 107	898, 754
1862	468, 107	325, 377	*793, 484	332, 468	270, 518	602, 986	800, 575	595, 895	1, 396, 470
1867†	491, 512	341, 645	833, 157	325, 120	268, 198	593, 318	816, 632	609, 843	1, 426, 475
1877‡	561, 315	379, 112	*940, 427	240, 251	229, 181	469, 432	801, 566	608, 293	*1, 409, 859

* Whites in Cuban statistics include Indians and Chinese, while the colored include only those of negro blood. In 1862 the number of Indians was only 735. Chinese were first introduced in 1847, and the last importation was in 1874. In 1862 there were 33,237, and 47,126 in 1877.

† In 1841 and in 1867 the census was not regularly taken, but "official" estimates were made of the population.

‡ In the above report of the census of 1877 the census of the jurisdiction of Holguin, having been long delayed because of the insurrection, was omitted. The following more recent report includes all parts of Cuba, and gives instead of 1,409,859 a sum total of 1,434,747.

TABLE No. 42.—*Population of Cuba, census*, 1877.

Provinces.*	Whites.			Chinese.†	Colored.‡	Totals.
	Cubans and Spaniards.	Foreigners.	Total.			
Havana*....................	298,388	3,951	302,339	10,108	111,096	423,543
Pinar del Rio	126,312	275	126,587	3,137	59,496	189,220
Matanzas....................	119,371	2,553	121,924	20,064	108,740	250,728
Santa Clara.................	200,916	1,216	202,132	13,301	96,959	312,392
Puerto Principe.............	46,664	229	46,893	94	8,472	55,459
Santiago de Cuba...........	114,831	1,353	116,184	422	86,799	203,405
Totals.................	906,482	9,577	916,059	47,126	471,562	1,434,747

*Cuba was at one time subdivided into the western and eastern departments; subsequently into the western, central, and eastern departments; and about 1878 into the above six provinces; these are again subdivided into 36 jurisdictions, and these into 127 municipalities. The province of Havana includes the Isle of Pines, which has about 2,200 population.

†Of the 47,126 Chinese 21,890 are specified as "free," and 25,236 as "under contract," or as "colonos."

‡Of the 471,562 colored population, 195,563, freed May 8, 1880, were slaves in 1877.

Births and deaths, or "baptisms" and "burials."

No statistics of births and deaths have been found for any other years, except for those which follow, and these are from the official censuses. Every statistician knows how little confidence is usually to be placed in national statistics of this kind; however, since those which follow are derived from the ecclesiastical authorities, who, in Catholic Cuba, derive profit from, promote religious prejudice through, and exercise strict jurisdiction over, baptisms and burials, it is believed that they are more reliable than are such reports in Protestant countries generally.

TABLE No. 43.

Year.	Baptisms.			Burials			Ratio of deaths per 1,000 population.
	White.	Colored.	Total.	White.	Colored.	Total.	
1827..........................	12,928	17,553	30,481	6,632	10,033	16,665	23.6
1842..........................	17,066	14,296	31,362	9,235	10,244	19,479	....
1843..........................	17,997	15,709	33,706	9,503	10,317	19,820	....
1844..........................	17,405	14,463	31,868	11,865	14,670	26,535	....
1845..........................	16,204	13,744	29,948	9,920	12,734	22,654	....
1846..........................	18,375	16,090	34,465	10,933	9,837	20,770	23.1
1862..........................	27,778	16,861	44,639	17,580	15,454	33,034	23.6

The ratio of deaths by races was in—

	White.	Colored.
1827	21.3	25.5
1846	25.6	20.8
1862	22.1	25.6

These figures demonstrate conclusively, as the statistics of all southern countries have invariably done, that the old idea that the negro surpassed the white man in enduring tropical or southern climates was false; and that, in truth, the colored death-rate is habitually greater. It will be seen above that only in 1846 did the white death-rate exceed the colored, but a glance at the data for the four preceding years, 1842–'45, shows that this was altogether exceptional, due perhaps to yellow fever.

TABLE No. 44.—*Deaths by sex and race in* 1862, *and ratio thereof to every* 1,000 *population.*

Sex.	White.		Colored.		White and colored.	
	Deaths.	Ratio.	Deaths.	Ratio.	Deaths.	Ratio.
Males	10,309	22.0	9,124	28.1	19,433	24.2
Females	7,271	22.3	6,330	23.4	13,601	22.8
Total	17,580	22.1	15,454	25.6	33,034	23.6

TABLE No. 45.—*Official statistics of population (stationary and floating, civil and military), and of yellow fever, in Cuba, 1851–1879.*

Years.	Stationary population.			Data as to the floating population at Havana.										Yellow-fever statistics.						
	Civil.	Military.		Civilians arriving at, and departing from, Havana, as reported by Spanish officials.				Civilians and soldiers arriving at, and departing from, Havana, as reported by the "Diario de la Marina," passengers in transit excluded.						Deaths by yellow fever in the civil hospitals, as reported by the "superior board of health."				Yellow fever in army and navy occurring in the military hospitals.		Total yellow-fever deaths in the civil hospitals (as reported by the superior board of health) and by the military hospitals.
				Arrived.			Departed.	Civilians.		Soldiers.		Total civilians and soldiers.								
		Army.	Navy.	Spanish.	Foreign.	Total.	Total.	Total arrived.	Total departed.	Total arrived.	Total departed.	Arrived.	Departed.	City of Havana.	Western department, exclusive of Havana.	Eastern department.	Total for Cuba.	Cases.	Deaths.	
A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	M.	N.	O.	P.	Q.	R.	S.	T.	U.
1851.		20, 612	2, 871	......	......	......	......	......	......	......	......	......	......	......	......	......	......	1, 528	270	......
1852.		19, 120	3, 351	......	......	......	......	......	......	......	......	......	......	......	......	......	......	838	92	......
1853.	Official estimate of civil population in 1851, 1,023,743, of whom 479,490 whites.	19, 203	3, 745	......	......	......	......	......	......	......	......	......	......	†769	......	......	......	1, 307	237	1, 006
1854.		18, 710	2, 674	*6, 401	......	......	......	......	......	*4, 719	......	*18, 578	......	†1, 284	......	......	......	2, 612	482	1, 766
1855.		17, 830	3, 439	*7, 853	......	......	......	......	......	*5, 286	......	*18, 356	......	......	......	......	......	1, 485	368	1, 565
1856.		18, 115	3, 976	*9, 717	......	......	......	......	......	*4, 624	......	*22, 186	......	1, 309	298	172	1, 779	2, 063	518	2, 297
1857.		19, 399	5, 281	*6, 876	......	......	......	......	......	*7, 024	......	*28, 775	......	2, 058	404	216	2, 678	4, 820	1, 558	4, 236
1858.		18, 365	3, 957	*5, 832	......	......	......	......	......	*5, 903	......	*31, 738	......	1, 396	623	253	2, 272	3, 528	1, 153	3, 425
1859.	......	18, 440	4, 520	*8, 464	......	......	......	......	......	*3, 871	......	*25, 270	......	1, 193	185	153	1, 531	3, 082	746	2, 277
1860.		19, 333	3, 522	......	......	......	......	......	......	......	......	......	......	439	125	22	586	1, 017	143	729
1861.	Official census 1862, 1,396,470, of whom 793,484 whites.	19, 221	5, 120	......	......	......	......	......	......	......	......	......	......	1, 020	177	8	1, 205	2, 365	608	1, 813
1862.		18, 569	5, 870	......	......	......	......	......	......	......	......	......	......	1, 386	209	27	1, 622	1, 918	602	2, 224
1863.		19, 582	5, 645	......	......	......	......	......	......	......	......	......	......	550	35	92	677	1, 914	520	1, 197
1864.		33, 799	4, 857	......	......	......	......	......	......	......	......	......	......	555	355	174	1, 084	2, 680	876	1, 960
1865.	......	32, 598	5, 057	8, 172	2, 431	10, 603	7, 756	......	......	......	......	......	......	238	237	307	782	2, 085	521	1, 303

1866.	Official estimate 1867, 1,426,475, of whom 833,157 whites.	27,571	3,773	10,234	2,489	12,723	6,754	....	....	....	....	....	....	51	24	45	120	104	30	150
1867.		25,837	3,317	9,214	3,699	12,913	6,674	....	....	....	....	....	....	591	96	97	784	1,446	309	1,093
1868.		22,079	2,961	6,744	2,677	9,421	5,607	....	....	....	....	....	....	290	179	50	519	1,127	347	866
1869.		39,071	4,033	6,842	1,808	8,650	10,410	....	....	35,650	....	....	....	1,000	385	61	1,446	5,247	2,214	3,660
1870	....	41,997	5,154	8,539	2,018	10,557	7,282	16,650	6,070	11,283	1,445	28,687	9,269	572	115	171	858	5,089	2,125	2,983
1871.	....	49,053	4,169	11,835	2,310	14,145	7,739	17,983	7,210	15,992	2,749	37,413	13,397	532	111	246	889	3,629	1,513	2,402
1872	....	54,864	3,692	11,985	3,823	15,808	8,917	20,743	9,519	9,328	5,102	34,787	19,207	268	43	525	836	5,135	2,424	3,260
1873.	....	43,896	3,729	14,475	2,758	17,233	10,234	21,596	8,592	12,917	3,919	39,054	17,052	538	175	41	754	2,785	1,004	1,758
1874	....	44,040	2,535	12,014	2,405	14,419	9,289	14,103	8,835	8,158	3,680	25,975	16,229	602	147	43	792	1,351	483	1,275
1875	Official census 1877, 1,409,859, of whom about 930,000 whites.	57,949	3,717	10,084	2,121	12,205	9,409	19,087	11,129	27,949	4,551	50,322	18,966	534	206	44	784	1,813	812	1,596
1876		98,130	4,894	11,452	2,277	13,729	9,715	24,782	11,002	35,290	5,736	63,162	19,828	469	240	195	904	6,557	2,857	3,761
1877.		99,495	4,097	11,627	2,431	14,058	9,717	24,532	11,895	10,332	10,257	36,875	24,163	1,414	152	123	1,689	5,583	3,352	5,041
1878.		87,850	2,974	17,375	2,882	20,257	10,490	32,730	10,150	4,891	17,892	40,585	31,006	787	170	432	1,389	3,198	1,891	3,280
1879.	....	47,130	3,003	12,436	2,354	14,790	10,959	20,175	12,865	18,283	11,123	43,116	18,746	933	84	129	1,146	......	......	1,146
	Total	......	......	......	......	......	......	......	......	......	......	......	......	18,725	4,775	3,626	27,126	76,356	28,055	55,917
	Number of cases corresponding to deaths, as reported by the superior board of health	......	......	......	......	......	......	......	......	......	......	......	......	66,314	16,949	10,005	93,268	93,268	......	......
	Total cases and deaths.	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	169,624	......	55,917

*Pezuela's Dict., v. 3, p. 374. †Pezuela, pp. 154, 156.

EXPLANATIONS OF, AND NOTES ON, TABLE No. 45.

If vital statistics in Cuba were trustworthy, this table, which has been the object of great labor and considerable expense, would be very valuable. It amounts as it is to little more than the best effort which was practicable to accomplish the very important end of illustrating the influence on yellow fever of annual variations in the unacclimated population. Until means are furnished to estimate this predominant influence, it will prove almost useless to attempt to estimate other influences, such as those due to meteorological changes.

All the data have been derived from official sources, and are reported because they are the nearest approximations to the truth obtainable, and not because of confidence in their correctness. The causes and character of the lack of correctness will be sufficiently indicated.

Column C, "Army," was derived from an official report from military headquarters at Havana.

Column D, "Navy," was derived from a report from navy headquarters, dated September 13, 1879, and refers to the "fleet of the Antilles," all of which appertains to Cuba, except "two vessels of small burden, which are in Puerto Rico."

The data in column E, as also in the columns K and M, for the six years 1854–'59, were derived from Pezuela's Dict, Geog., &c., and have been inserted in order to compare past years with more recent years. The data for all other years in columns E, F, G, were derived from an official report of the "inspector of vessels" at Havana, while column H was derived from the "Bureau of Passports."

The data in columns I, J, K, L, M, N, for the years 1869 to December 31, 1879, were kindly compiled by the United States consul-general's office from the reports published in the daily newspaper, the Diario de la Marina," and were obtained and are presented for the purpose of testing the correctness of the data in columns E, F, G, H. For instance, the figures in columns G and H ought to correspond exactly with those in columns I and J, but as will be seen the discrepancies are great.

The chief cause for the discrepancies between these two sets of data is, as reported by Consul-General H. C. Hall, probably due to the fact that the data of the Diario de la Marina report all persons in a family, while the other set of data report only those persons having passports; some of these may cover several persons in one family, such as children, &c. It becomes necessary to compare the two sets of data, in order to arrive at approximations to the truth. In both sets of data crews of vessels are excluded, and emigrants from Spanish dominions included.

The data of the Cuban superior board of health, columns O, P, Q, R, are by no means correct, and serve solely as approximations which may justify comparison of different years with each other. The secretary of this board, Dr. V. L. Ferrer, reported as follows: "The statistics of the superior board of health include only the civil hospitals, public and private, and not the whole mass of the civil population. Hence, the mortality statistics of Havana, to this day, are reported accurately only by Dr. Del Valle, and the many discrepancies which are observed between these and other statistics are due to the lack of exactitude on the part of civil hospitals, in reporting to the superior board of health, and to the absolute neglect to report on the part of the military hospitals, and of the civil physicians, who have always refused to render this important service. Should the service become well organized, the board would be able to report exact statistical data." The statistics of Dr. Del Valle for Havana are published elsewhere for the 10 years, 1870–'79, and if these be compared with the corresponding statistics of the board of health, the resulting discrepancies suffice to destroy confidence in those of the board. Its report of only 150 deaths in Cuba in 1866 is very remarkable. Inquiry resulted in the conviction that, while this number much underrated the truth, yet, that there was in Cuba less yellow fever in 1866 than usual. The statistics of the board were published in the March No. 1880 of the Cronica Medico Quirurgica of Havana; but in this there are so many manifest errors of addition, &c., that the data in the above table were taken from the original manuscript of the official report to the United States commission, and are believed to be the more correct. It is to be noticed, that while "Havana" and the "Western department" are reported in separate columns, yet the former is a part of the latter; and that the population of the "Eastern department" is about two-sevenths, while that of the Western department, including Havana, is about five-sevenths of the whole population of Cuba.

Greater, but by no means implicit, confidence is due to the military-hospital statistics. They do not accord for 1853–'54 with those then published by Peñuela, nor for 1855–'59 with those published by Pezuela; and they contain some errors which, though manifest, cannot now be corrected. The military hospitals admit not only soldiers, but also sailors of the Spanish navy, and these are included in the total cases

and deaths. However, a special report separated the sailors from the soldiers for the 9½ years, January, 1870, July, 1879, and is as follows:

Cases and deaths of yellow fever in the Spanish navy.

Year.	Cases.	Deaths.
1870	1,094	231
1871	105	41
1872	192	87
1873	188	83
1874	825	129
1875	631	203
1876	324	75
1877	429	156
1878	526	163
First six months 1879	305	90
Total	4,064	1,158

The last column, U, is the sum of columns R and T, except for the years 1853, 1854, 1855 (taken from Peñuela and Pezuela), and therefore is invalidated by all the objections to which the two latter columns are liable.

TABLE No. 46.—*Annual statistics of all of the 38 military hospitals which have existed in Cuba at 37 different places during the 28½ years from 1851 to June, 1879, inclusive.*

[Compiled from 556 pages in manuscript of official monthly reports furnished the United States commission, and never before published.]

Number.	Location of military hospitals.			Years reported.	Number of years.	1851.			
						All diseases.		Yellow fever.	
	City, town, or village.	Province.	Port.*			Admitted.	Died.	Admitted.	Died.
1	Bahia Honda†	Pinar del Rio	N. P.	1858-'72	15	...	...	...	...
2	Baracoa	Cuba	N. P.	1851-'79	28½	833	2	0	0
3	Bayamo	Cuba	...	1851-'79	28½	920	15	0	0
4	Cabanas	Rinar del Rio	N. P.	1860-'67	8	...	...	...	...
5	Cardenas	Matanzas	N. P.	1852-'70	19	...	...	...	...
6	Ciego de Avila	Puerto Principe	...	1869-'79	10½	...	...	...	...
7	Cienfuegos	Santa Clara	S. P.	1851-'78	28	572	21	65	10
8	Cuba (Santiago de)	Cuba	S. P.	1851-'79	28½	4, 326	64	98	14
9	Gibara	Cuba	N. P.	1858-'79	21½	...	...	...	...
10	Guanabacoa†	Havana	...	1852-'66	15	...	...	...	...
11	Guanajay	Pinar del Rio	...	1852-'70	19	...	...	...	...
12	Guantanamo	Cuba	S. P.	1851-'62 } 1868-'79 }	25½	247	1	0	0
13	Güines†	Havana	...	1855-'68	14	...	...	...	...
14 } 15 }	Havana‡	Havana	N. P.	1851-'79	28½	8, 366	422	687	141
16	Holguin	Cuba	...	1851-'79	28½	1, 439	168	427	59
17	Isle de Pinos†	Havana	S. P.	1851-'79	28½	174	3	0	0
18	Jaruco†	Havana	...	1851-'53 } 1860-'61 }	5	22	0	0	0
19	Jiguani	Cuba	...	1871-'78	8	...	...	...	...
20	Manzanillo	Cuba	S. P.	1851-'79	28½	291	4	0	0
21	Mariel†	Pinar del Rio	N. P.	1857-'67	11	...	...	...	...
22	Matanzas	Matanzas	N. P.	1851-'78	28	1, 292	88	58	9
23	Mayari	Cuba	N. P.	1862-'64 } 1871-'78 }	11	...	...	...	...
24	Moron	Puerto Principe	...	1869-'78	10	...	...	...	...
25	Nuevitas	Puerto Principe	N. P.	1851-'62 } 1869-'78 }	22	310	13	12	6
26	Palma Soriano	Cuba	...	1874-'78	5	...	...	...	...
27	Pinar del Rio†	Pinar del Rio	...	1851-'70	20	775	21	0	0
28	Puerto del Padre	Cuba	N. P.	1874-'78	5	...	...	...	...
29	Puerto Principe	Puerto Principe	...	1851-'79	28½	2, 535	46	172	30
30	Remedios	Santa Clara	...	1851-'79	28½	75	2	0	0
31	Sagua la Grande	Santa Clara	N. P.	1851-'72	22	134	1	0	0
32	San Antonio†	Havana	...	1851-'70	20	222	9	0	0
33	Sancti Spiritus	Santa Clara	...	1851-'79	28½	354	12	0	0
34	Santa Clara†	Santa Clara	...	1851-'79	28½	1, 774	17	0	0
35	Santa Cruz del Sur	Puerto Principe	S. P.	1851-'78	28	91	1	9	1
36	Santiago de las Vegas†	Havana	...	1854-'66 } 1876-'79 }	17	...	...	...	...
37	Trinidad	Santa Clara	S. P.	1851-'79	28½	1, 021	11	0	0
38	Victoria de las Tunas	Cuba	...	1855-'78	24	...	...	...	...
						25, 773	921	1, 528	270

* N. P., northern port; S. P., southern port.
† Acclimating hospital.
‡ Hospital of San Ambrosio was the only military hospital at Havana until the Hospital Madera was established and opened January, 1870. The number of patients which have been in these, respectively, will be found in a foot-note attached to the statistics of 1870, &c. San Ambrosio is very unfavorably located on the harbor, while the Hospital Madera has an elevated and admirable location.

TABLE No. 46—Continued.

Number.	City, town, or village.	1852.				1853.			
		All diseases.		Yellow fever.		All diseases.		Yellow fever.	
		Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.
1	Bahia Honda	....	....	....	....	....	....	....	....
2	Baracoa	1,181	2	0	0	275	2	6	0
3	Bayamo	1,081	42	6	0	1,061	52	53	11
4	Cabanas	....	....	....	....	....	....	....	....
5	Cardenas	888	12	0	0	600	16	0	0
6	Ciego de Avila	....	....	....	....	....	....	....	....
7	Cienfuegos	485	9	47	0	898	22	49	15
8	Cuba (Santiago de)	8,111	90	108	7	2,779	53	84	8
9	Gibara	....	....	....	....	....	....	....	....
10	Guanabacoa	72	1	0	0	51	10	17	8
11	Guanajay	867	18	0	0	507	10	10	2
12	Guantaname	819	11	2	0	450	2	0	0
13	Güines	....	....	....	....	....	....	....	....
14, 15	Havana	6,823	559	618	65	8,873	771	1,058	189
16	Holguin	962	7	7	0	571	25	7	0
17	Isle de Pinos	133	8	0	0	192	5	0	0
18	Jaruco	24	0	0	0	23	0	0	0
19	Jiguani	....	....	....	....	....	....	....	....
20	Manzanillo	197	9	0	0	188	10	0	0
21	Mariel	....	....	....	....	....	....	....	....
22	Mantanzas	1,588	35	0	0	1,710	155	6	0
23	Mayari	....	....	....	....	....	....	....	....
24	Moron	....	....	....	....	....	....	....	....
25	Nuevitas	878	9	27	3	188	14	11	7
26	Palma Soriano	....	....	....	....	....	....	....	....
27	Pinar del Rio	530	7	0	0	616	12	2	1
28	Puerto del Padre	....	....	....	....	....	....	....	....
29	Puerto Principe	3,833	47	29	17	2,688	28	8	1
30	Remedios	193	1	0	0	123	3	0	0
31	Sagua la Grande	122	0	0	0	58	8	0	0
32	San Antonio	171	3	0	0	239	6	7	0
33	Sancti Spiritus	161	2	0	0	247	2	0	0
34	Santa Clara	961	36	0	0	981	9	6	0
35	Santa Cruz del Sur	84	1	0	0	82	1	0	0
36	Santiago de las Vegas	....	....	....	....	....	....	....	....
37	Trinidad	935	12	0	0	1,078	23	0	0
38	Victoria de las Tunas	....	....	....	....	....	....	....	....
		23,560	930	838	92	23,908	1,234	*1,307	*237

*Peñuela, p. 37, gives these figures: 2,061 cases, 438 deaths.

TABLE No. 46—Continued.

Number.	City, town, or village.	1854.				1855.			
		All diseases.		Yellow fever.		All diseases.		Yellow fever.	
		Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.
1	Bahia Honda	....	....	....	....	....	....	....	....
2	Baracoa	1,528	3	0	0	864	14	31	8
3	Bayamo	960	68	108	13	749	10	6	1
4	Cabanas	....	....	....	....	....	....	....	....
5	Cardenas	963	89	111	20	103	5	2	1
6	Ciego de Avila	....	....	....	....	....	....	....	....
7	Cienfuegos	445	13	20	4	199	1	43	0
8	Cuba (Santiago de)	4,948	66	76	10	3,811	121	322	61
9	Gibara	....	....	....	....	....	....	....	....
10	Guanabacoa	65	6	5	2	285	4	0	0
11	Guanajay	463	24	0	0	439	22	36	14
12	Guantanamo	474	3	0	0	415	6	30	2
13	Güines	....	....	....	....	177	31	39	13
14, 15	Havana	9,763	647	*1,715	*256	13,789	753	509	173
16	Holguin	689	9	0	0	563	67	56	16
17	Isle de Pinos	123	17	0	0	539	11	2	0
18	Jaruco	....	....	....	....	....	....	....	....
19	Jiguani	....	....	....	....	....	....	....	....
20	Manzanillo	87	5	0	0	182	4	1	0
21	Mariel	....	....	....	....	....	....	....	....
22	Matanzas	1,656	44	0	0	859	10	14	1
23	Mayari	....	....	....	....	....	....	....	....
24	Moron	....	....	....	....	....	....	....	....
25	Nuevitas	113	2	0	0	272	20	35	14
26	Palma Soriano	....	....	....	....	....	....	....	....
27	Pinar del Rio	796	72	184	42	564	9	0	0
28	Puerto del Padre	....	....	....	....	....	....	....	....
29	Puerto Principe	2,186	77	193	43	3,455	142	347	64
30	Remedios	196	3	0	0	76	2	0	0
31	Sagua la Grande	40	0	0	0	112	4	1	0
32	San Antonio	382	37	87	26	291	4	4	0
33	Sancti Spiritus	516	40	44	31	990	16	0	0
34	Santa Clara	1,216	70	17	7	963	8	0	0
35	Santa Cruz del Sur	89	2	0	0	71	0	0	0
36	Santiago de las Vegas	.215	4	0	0	283	5	3	0
37	Trinidad	952	50	52	28	862	19	3	0
38	Victoria de las Tunas	....	....	....	....	999	34	1	0
		28,860	1,301	†2,612	†482	31,912	1,322	1,485	368

* The military hospital reports in MSS. give 193 cases, 43 deaths, but in said report a number of months are omitted, and Penuela's Topog. Med. de Cuba, 1855, p. 158, gives 1,715 cases, 256 deaths, as above.

† Penuela, p. 37, gives these figures: 2,878 cases, 622 deaths.

TABLE No. 46—Continued.

Number.	City, town, or village.	1856.				1857.			
		All diseases.		Yellow fever.		All diseases.		Yellow fever.	
		Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.
1	Bahia Honda								
2	Baracoa	548	13	16	7	553	3	0	0
3	Bayamo	925	19	15	2	982	21	15	7
4	Cabanas								
5	Cardenas	62	2	0	0	453	7	9	8
6	Ciego de Avila								
7	Cienfuegos	273	10	27	6	435	4	0	0
8	Cuba (Santiago de)	5,656	126	266	83	4,493	183	303	109
9	Gibara								
10	Guanabacoa	331	3	1	0	268	18	20	11
11	Guanajay	668	18	53	8	983	25	75	18
12	Guantanamo	372	16	20	12	314	6	1	1
13	Güines	104	0	0	0	405	11	2	0
14, 15	Havana	11,449	739	1,226	310	15,534	1,515	3,339	1,041
16	Holguin	998	28	31	12	987	140	245	81
17	Isle de Pinos	1,504	40	75	31	1,422	15	6	1
18	Jaruco								
19	Jiguani								
20	Manzanillo	250	2	17	0	188	0	0	0
21	Mariel					820	7	0	0
22	Matanzas	874	27	40	12	1,251	153	288	112
23	Mayari								
24	Moron								
25	Nuevitas	176	17	18	5	215	17	1	1
26	Palma Soriano								
27	Pinar del Rio	1,067	12	8	2	1,320	85	92	38
28	Puerto del Padre								
29	Puerto Principe	2,239	96	45	10	2,546	116	145	51
30	Remedios	109	2	0	0	626	59	89	32
31	Sagua la Grande	348	27	17	9	232	18	10	5
32	San Antonio	349	35	24	9	197	18	34	14
33	Sancti Spiritus	648	40	84	27	478	4	1	0
34	Santa Clara	1,058	21	0	0	1,620	20	33	17
35	Santa Cruz del Sur	77	0	0	0	76	0	0	0
36	Santiago de las Vegas	394	12	40	7	641	3	24	1
37	Trinidad	731	48	40	15	1,240	74	93	15
38	Victoria de las Tunas	220	3	5	1	98	2	0	0
		30,430	1,356	2,063	518	37,872	2,524	4,830	1,558

TABLE No. 46—Continued.

Number.	City, town, or village.	1858.				1859.			
		All diseases.		Yellow fever.		All diseases.		Yellow fever.	
		Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.
1	Bahia Honda	192	1	0	0	90	2	0	0
2	Baracoa	596	6	3	1	1,390	4	2	0
3	Bayamo	485	14	0	0	1,014	80	233	75
4	Cabanas	...	...	...	...	...	...	...	...
5	Cardenas	587	34	83	14	512	6	15	0
6	Ciego de Avila	...	...	...	...	...	...	...	...
7	Cienfuegos	556	13	52	6	427	6	34	2
8	Cuba (Santiago de)	4,958	249	277	116	3,884	70	21	2
9	Gibara	115	14	10	6	158	12	27	8
10	Guanabacoa	285	11	29	4	156	7	9	4
11	Guanajay	691	13	0	0	426	20	19	9
12	Guantanamo	249	9	5	0	212	9	3	0
13	Güines	592	47	78	21	539	11	9	4
14, 15	Havana	17,696	987	1,815	473	18,260	907	1,723	440
16	Holguin	196	14	28	5	596	61	152	55
17	Isle de Pinos	860	51	3	0	751	66	25	9
18	Jaruco	...	...	...	...	...	...	...	...
19	Jiguani	...	...	...	...	...	...	...	...
20	Manzanillo	71	2	10	1	208	8	25	3
21	Mariel	314	6	0	0	364	7	0	0
22	Matanzas	1,967	259	364	227	2,084	26	53	5
23	Mayari	...	...	...	...	...	...	...	...
24	Moron	...	...	...	...	...	...	...	...
25	Nuevitas	221	24	0	0	183	8	2	0
26	Palma Soriano	...	...	...	...	...	...	...	...
27	Pinar del Rio	826	50	0	0	929	102	262	69
28	Puerto del Padre	...	...	...	...	...	...	...	...
29	Puerto Principe	2,752	218	387	146	2,397	13	285	0
30	Remedios	397	65	178	53	359	0	0	0
31	Sagua La Grande	292	19	31	12	388	9	10	0
32	San Antonio	198	3	0	0	242	11	14	10
33	Sancti Spiritus	611	37	77	36	350	13	18	6
34	Santa Clara	741	31	18	12	426	5	9	0
35	Santa Cruz del Sur	56	0	0	0	108	2	6	2
36	Santiago de la Vegas	711	21	61	11	955	20	78	13
37	Trinidad	1,009	20	18	8	689	40	107	30
38	Victoria de las Tunas	35	7	1	1	36	2	9	0
		38,259	2,225	3,528	1,158	37,632	1,612	3,082	746

TABLE No. 46—Continued.

Number.	City, town, or village.	1860. All diseases. Admitted.	1860. All diseases. Died.	1860. Yellow fever. Admitted.	1860. Yellow fever. Died.	1861. All diseases. Admitted.	1861. All diseases. Died.	1861. Yellow fever. Admitted.	1861. Yellow fever. Died.
1	Bahia Honda	120	1	0	0	65	1	0	0
2	Baracoa	1,082	6	0	0	476	3	0	0
3	Bayamo	1,167	8	0	0	491	6	0	0
4	Cabanas	66	2	0	0	76	3	0	0
5	Cardenas	702	10	9	1	277	17	30	14
6	Ciego de Avila	.....	.....	.....	.....	.....	.....	.....	.....
7	Cienfuegos	281	10	12	3	269	3	31	0
8	Cuba (Santiago de)	2,954	74	27	10	2,527	44	5	1
9	Gibara	132	5	0	0	66	0	0	0
10	Guanabacoa	188	0	0	0	156	0	2	0
11	Guanajay	405	4	0	0	197	2	4	1
12	Guantanamo	141	1	4	0	102	1	0	0
13	Güines	271	1	1	0	119	1	0	0
14, 15	Havana	14,743	534	622	83	15,962	923	1,766	490
16	Holguin	486	4	0	0	812	1	0	0
17	Isle de Pinos	324	27	1	0	184	16	0	0
18	Jaruco	187	4	1	0	94	3	1	1
19	Jiguani	.....	.....	.....	.....	.....	.....	.....	.....
20	Manzanillo	235	12	34	4	108	1	0	0
21	Mariel	307	9	0	0	300	36	113	36
22	Matanzas	1,383	41	173	18	1,046	15	61	11
23	Mayari	.....	.....	.....	.....	.....	.....	.....	.....
24	Moron	.....	.....	.....	.....	.....	.....	.....	.....
25	Nuevitas	212	4	8	1	99	1	0	0
26	Palma Soriano	.....	.....	.....	.....	.....	.....	.....	.....
27	Pinar del Rio	299	7	0	0	195	3	3	1
28	Puerto del Padre	.....	.....	.....	.....	.....	.....	.....	.....
29	Puerto Principe	3,202	24	5	3	2,418	26	78	16
30	Remedios	143	5	9	2	90	2	0	0
31	Sagua la Grande	207	13	18	5	130	5	32	1
32	San Antonio	262	3	3	1	258	13	62	11
33	Sancti Spiritus	320	7	4	1	250	2	7	2
34	Santa Clara	299	4	0	0	395	1	0	0
35	Santa Cruz del Sur	31	1	0	0	31	1	0	0
36	Santiago de las Vegas	493	18	41	9	768	32	156	21
37	Trinidad	836	11	45	2	295	5	14	2
38	Victoria de las Tunas	130	6	0	0	40	1	0	0
		31,608	856	1,017	143	27,796	1,168	2,365	608

TABLE No. 46—Continued.

Number.	City, town, or village.	1862.				1863.			
		All diseases.		Yellow fever.		All diseases.		Yellow fever.	
		Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.
1	Bahia Honda	62	0	0	0	121	0	0	0
2	Baracoa	585	6	0	0	481	6	1	0
3	Bayamo	489	1	0	0	259	2	0	0
4	Cabanas	85	0	0	0	42	1	0	0
5	Cardenas	641	7	16	8	822	9	4	0
6	Ciego de Avila	......	......	......	......	......	......	......	......
7	Cienfuegos	322	2	0	0	467	4	7	2
8	Cuba (Santiago de)	2,416	61	74	22	5,639	228	818	116
9	Gibara	77	0	0	0	66	6	14	4
10	Guanabacoa	278	4	8	0	142	8	0	0
11	Guanajay	493	31	81	15	43	0	7	2
12	Guantanamo	586	6	0	0	......	......	......	......
13	Güines	179	0	0	0	98	2	0	0
14, 15	Havana	20,113	1,155	1,415	478	16,089	792	1,406	379
16	Holguin	109	8	0	0	85	2	0	0
17	Isle de Pinos	241	25	0	0	288	9	8	2
18	Jaruco	......	......	......	......	......	......	......	......
19	Jiguani	......	......	......	......	......	......	......	......
20	Manzanillo	108	8	7	1	81	0	0	0
21	Mariel	122	6	18	8	150	2	16	0
22	Matanzas	1,874	51	218	42	848	4	18	1
23	Mayari	23	0	0	0	24	0	0	0
24	Moron	......	......	......	......	......	......	......	......
25	Nuevitas	6	0	0	0	......	......	......	......
26	Palma Soriano	......	......	......	......	......	......	......	......
27	Pinar del Rio	431	27	25	11	323	11	21	4
28	Puerto del Padre	......	......	......	......	......	......	......	......
29	Puerto Principe	2,318	83	40	11	1,646	11	4	2
30	Remedios	209	2	0	0	210	0	0	0
31	Sagua la Grande	131	1	0	0	117	0	0	0
32	San Antonio	534	27	47	10	814	10	23	5
33	Sancti Spiritus	190	1	0	0	132	0	1	0
34	Santa Clara	1,041	10	8	2	954	6	0	0
35	Santa Cruz del Sur	26	0	0	0	22	0	0	0
36	Santiago de las Vegas	1,002	19	20	4	327	4	11	3
37	Trinidad	188	1	1	0	309	4	0	0
38	Victoria de las Tunas	29	0	0	0	37	0	0	0
		34,758	1,482	1,918	602	29,586	1,105	1,914	520

TABLE No. 46—Continued.

Number.	City, town, or village.	1864.				1865.			
		All diseases.		Yellow fever.		All diseases.		Yellow fever.	
		Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.
1	Bahia Honda	68	0	0	0	307	1	0	0
2	Baracoa	89	1	0	0	778	8	5	2
3	Bayamo	65	12	18	9	316	0	0	0
4	Cabanas	50	1	0	0	82	1	20	0
5	Cardenas	817	22	43	14	1,067	58	64	28
6	Ciego de Avila	...	...	...	...	...	...	...	...
7	Cienfuegos	133	9	14	4	441	14	40	11
8	Cuba (Santiago de)	12,262	909	699	260	11,943	625	467	127
9	Gibara	24	3	1	1	277	6	0	0
10	Guanabacoa	58	3	2	1	56	0	0	0
11	Guanajay	1,055	86	4	0	1,050	84	2	1
12	Guantanamo	...	...	...	...	...	...	...	...
13	Güines	68	0	7	3	345	10	6	6
14, 15	Havana	22,437	1,151	715	224	13,544	601	377	73
16	Holguin	60	0	0	0	464	47	30	18
17	Isle de Pinos	577	32	45	16	947	53	6	1
18	Jaruco	...	...	...	...	...	...	...	...
19	Jiguani	...	...	...	...	...	...	...	...
20	Manzanillo	38	0	0	0	125	3	2	0
21	Mariel	84	2	8	2	176	0	0	0
22	Matanzas	2,135	105	344	77	2,027	92	227	74
23	Mayari	41	0	0	0	...	...	...	...
24	Moron	...	...	...	...	...	...	...	...
25	Nuevitas	...	...	...	...	...	...	...	...
26	Palma Soriano	...	...	...	...	...	...	...	...
27	Pinar del Rio	404	6	7	2	560	2	3	0
28	Puerto del Padre	...	...	...	...	...	...	...	...
29	Puerto Principe	4,108	157	8	6	3,618	324	739	158
30	Remedios	15	0	0	0	307	6	0	0
31	Sagua la Grande	50	2	1	1	69	0	0	0
32	San Antonio	549	46	91	29	487	2	0	0
33	Sancti Spiritus	82	2	1	1	288	21	76	20
34	Santa Clara	3,324	228	592	208	2,347	13	0	0
35	Santa Cruz del Sur	30	2	0	0	74	1	0	0
36	Santiago de las Vegas	1,577	70	26	6	2,761	81	0	0
37	Trinidad	247	23	49	15	618	11	21	2
38	Victoria de las Tunas	42	0	5	2	100	8	0	0
		49,964	2,822	2,680	876	45,150	2,023	2,085	521

TABLE No. 46—Continued.

Number.	City, town, or village.	1866.				1867.			
		All diseases.		Yellow fever.		All diseases.		Yellow fever.	
		Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.
1	Bahia Honda	335	4	0	0	166	4	0	0
2	Baracoa	870	10	4	2	459	7	21	5
3	Bayamo	388	21	22	10	409	18	23	9
4	Cabanas	124	0	0	0	67	0	0	0
5	Cardenas	845	8	1	1	798	11	8	1
6	Ciego de Avila								
7	Cienfuegos	403	4	5	0	311	12	65	6
8	Cuba (Santiago de)	3,703	32	10	4	2,290	47	54	17
9	Gibara	70	0	0	0	108	1	0	0
10	Guanabacoa	95	2	0	0				
11	Guanajay	474	5	0	0	544	21	59	14
12	Guantanamo	530	4	0	0	329	10	47	8
13	Güines	226	9	3	3	65	0	0	0
14, 15	Havana	12,461	300	48	7	13,635	669	1,144	238
16	Holguin	139	3	0	0	102	1	0	0
17	Isle de Pinos	451	20	0	0	261	26	0	0
18	Jaruco								
19	Jiguani								
20	Manzanillo	153	1	0	0	96	3	21	1
21	Mariel	149	0	0	0	65	1	0	0
22	Matanzas	1,471	6	0	0	920	27	45	9
23	Moyari								
24	Maron								
25	Nuevitas								
26	Palma Soriano								
27	Pinar del Rio	814	14	3	0	423	2	1	0
28	Puerto del Padre								
29	Puerto Principe	1,484	16	0	0	1,219	5	3	1
30	Remedios	265	6	4	3	151	3	0	0
31	Sagua la Grande								
32	San Antonio	216	1	2	0	108	0	0	0
33	Sancti Spiritus	218	3	0	0	169	1	2	0
34	Santa Clara	1,477	12	1	0	1,022	2	0	0
35	Santa Cruz del Sur	68	1	0	0	75	1	0	0
36	Santiago de las Vegas	1,093	4	0	0				
37	Trindad	277	3	1	0	358	1	3	0
38	Victoria de las Tunas	46	0	0	0	51	1	0	0
		28,845	489	104	30	24,201	874	1,496	309

TABLE No. 46—Continued.

Number.	City, town, or village.	1868.				1869.			
		All diseases.		Yellow fever.		All diseases.		Yellow fever.	
		Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.
1	Bahia Honda	168	0	0	0	129	1	0	0
2	Baracoa	205	1	3	0	574	5	2	0
3	Bayamo	816	18	53	13	2,818	296	262	105
4	Cabanas	...	...	...	...	...	...	...	...
5	Cardenas	521	17	61	5	328	14	49	10
6	Ciego de Avila	...	...	...	...	516	23	23	3
7	Cienfuegos	277	32	116	28	605	5	186	87
8	Cuba (Santiago de)	2,196	86	28	2	6,418	486	539	284
9	Gibara	138	3	0	0	1,345	49	39	23
10	Guanabacoa	...	...	...	...	...	...	...	...
11	Guanajay	671	35	35	4	245	13	13	6
12	Guantanamo	137	4	6	0	597	20	8	0
13	Güines	66	2	0	0	...	...	...	...
14, 15	Havana	10,743	621	472	167	10,356	945	1,892	665
16	Holguin	159	2	0	0	1,748	48	26	9
17	Isle de Pinos	216	9	0	0	218	9	0	0
18	Jaruco	...	...	...	...	...	...	...	...
19	Jiguani	...	...	...	...	...	...	...	...
20	Manzanillo	248	30	35	18	2,586	175	214	107
21	Mariel	...	...	...	...	...	...	...	...
22	Matanzas	632	24	10	0	483	67	85	33
23	Mayari	...	...	...	...	...	...	...	...
24	Maren	...	...	...	...	850	78	30	13
25	Nuevitas	...	...	...	...	5,323	209	115	53
26	Palma Soriano	...	...	...	...	...	...	...	...
27	Pinar del Rio	270	5	1	0	434	31	96	24
28	Puerto del Padre	...	...	...	...	...	...	...	...
29	Puerto Principe	1,178	34	63	22	8,960	669	661	335
30	Remedios	135	2	1	1	783	36	120	64
31	Sagua la Grande	...	...	...	...	617	11	9	1
32	San Antonio	122	5	3	2	196	4	13	3
33	Sancti Spirtus	242	16	5	3	1,080	268	326	153
34	Santa Clara	649	61	123	36	2,174	246	296	102
35	Santa Cruz del Sur	...	...	...	...	654	57	73	11
36	Santiago de las Vegas	...	...	...	...	...	...	...	...
37	Trindad	396	52	113	46	680	116	125	89
38	Victoria de las Tunas	370	6	0	0	2,221	275	178	85
		20,052	1,015	1,127	347	53,491	4,158	5,247	2,214

TABLE No. 46—Continued.

Number.	City, town, or village.	1870.				1871.			
		All diseases.		Yellow fever.		All diseases.		Yellow fever.	
		Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.
1	Bahia Honda	121	8	5	4	96	8	0	0
2	Baracoa	513	1	1	1	505	13	24	8
3	Bayamo	2,979	179	128	44	1,956	100	10	4
4	Cabanas	....	....	....	....	....	....	....	....
5	Cardenas	196	3	12	1	....	....	....	....
6	Ciego de Avila	2,083	211	18	9	4,802	345	508	208
7	Cienfuegos	1,098	58	78	29	598	33	50	11
8	Cuba (Santiago de)	6,704	727	539	419	5,658	468	389	256
9	Gibara	669	27	1	0	780	90	92	35
10	Guanabocoa	....	....	....	....	....	....	....	....
11	Guanajay	58	4	0	0	....	....	....	....
12	Guantanamo	749	38	10	8	2,599	100	22	11
13	Güines	....	....	....	....	....	....	....	....
14, 15	Havana	12,688	928	1,741	388	12,654	807	499	195
16	Holguin	2,789	287	136	46	2,492	118	118	18
17	Isle de Pinos	189	7	0	0	187	7	0	0
18	Jaruco	....	....	....	....	....	....	....	....
19	Jiguani	....	....	....	....	1,181	102	5	4
20	Manzanillo	4,181	179	259	50	3,870	278	172	66
21	Mariel	....	....	....	....	....	....	....	....
22	Matanzas	330	5	4	1	794	15	5	1
23	Mayari	....	....	....	....	1,371	22	14	1
24	Moron	1,775	102	122	33	2,720	205	405	146
25	Nuevitas	5,237	168	82	43	3,854	141	68	37
26	Palma Soriano	....	....	....	....	....	....	....	....
27	Pinar del Rio	86	0	0	0	....	....	....	....
28	Puerto dol Padre	....	....	....	....	....	....	....	....
29	Puerto Principe	15,782	1,092	1,145	567	13,029	608	620	255
30	Remedios	1,877	214	206	126	1,188	101	273	71
31	Sagua la Grande	399	19	3	3	212	4	1	0
32	San Antonio	58	3	0	0	....	....	....	....
33	Sancti Spiritus	2,627	372	405	249	5,841	112	57	25
34	Santa Clara	1,545	97	69	21	3,130	153	108	36
35	Santa Cruz del Sur	1,117	17	27	4	2,398	60	43	16
36	Santiago de las Vegas	....	....	....	....	....	....	....	....
37	Trinidad	1,680	141	98	79	3,018	202	88	64
38	Victoria de las Tunas	3,984	138	0	0	5,068	350	68	45
		70,904	4,975	5,089	2,125	79,791	4,427	3,629	1,513
	Of these there were in the wards of the Hospital de Madera, from January, 1870, to July, 1879	2,516	95	579	60	3,293	147	174	65
	And in San Ambrosio	10,172	838	1,162	828	9,361	660	825	180

TABLE No. 46—Continued.

Number.	City, town, or village.	1872. All diseases. Admitted.	1872. All diseases. Died.	1872. Yellow fever. Admitted.	1872. Yellow fever. Died.	1873. All diseases. Admitted.	1873. All diseases. Died.	1873. Yellow fever. Admitted.	1873. Yellow fever. Died.
1	Bahia Honda	45	1	0	0	......	......	......	......
2	Baracoa	588	8	9	3	384	8	1	0
3	Bayamo	2,997	341	602	208	2,491	270	426	165
4	Cabanas	......	......	......	......	......	......	......	......
5	Cardenas	......	......	......	......	......	......	......	......
6	Ciego de Avila	4,083	77	35	11	3,480	108	0	0
7	Cienfuegos	348	16	15	8	372	11	17	5
8	Cuba (Santiago de)	7,961	736	709	346	5,431	185	90	12
9	Gibara	1,816	147	156	87	974	41	13	7
10	Guanabacoa	......	......	......	......	......	......	......	......
11	Guanajay	......	......	......	......	......	......	......	......
12	Guantanamo	4,091	397	263	159	1,861	63	25	1
13	Güines	......	......	......	......	......	......	......	......
14, 15	Havana	18,431	952	513	143	12,959	780	655	225
16	Holguin	5,616	583	732	375	4,163	134	190	21
17	Isle de Pinos	354	8	0	0	207	8	0	0
18	Jaruco	......	......	......	......	......	......	......	......
19	Jiguani	1,519	143	60	35	1,120	228	175	121
20	Manzanillo	5,274	577	491	253	3,699	241	138	74
21	Mariel	......	......	......	......	......	......	......	......
22	Matanzas	643	5	12	1	367	13	18	6
23	Mayari	1,204	78	53	27	694	18	16	3
24	Moron	1,969	39	42	13	964	16	0	0
25	Nuevitas	3,488	252	202	98	3,558	212	61	23
26	Palma Soriano	......	......	......	......	......	......	......	......
27	Pinar del Rio	......	......	......	......	......	......	......	......
28	Puerto del Padre	......	......	......	......	......	......	......	......
29	Puerto Principe	13,881	647	172	57	14,403	695	894	321
30	Remedios	830	40	37	17	277	6	0	0
31	Sagua la Grande	188	3	0	0	......	......	......	......
32	San Antonio	......	......	......	......	......	......	......	......
33	Sancti Spiritus	2,904	146	219	112	1,333	24	18	8
34	Santa Clara	1,588	129	120	57	704	29	7	3
35	Santa Cruz del Sur	2,157	202	291	118	1,400	45	42	6
36	Santiago de las Vegas	......	......	......	......	......	......	......	......
37	Trinidad	1,666	157	134	92	670	13	1	1
38	Victoria de las Tunas	5,397	523	268	204	1,697	106	13	2
		89,058	6,207	5,135	2,424	63,208	3,249	2,785	1,004
	Of these there were in the wards of the Hospital de Madera, from January, 1870, to July, 1879	4,943	269	227	67	3,373	124	71	18
	And in San Ambrosio	13,488	683	286	76	9,586	654	584	207

TABLE No. 46—Continued.

Number.	City, town, or village.	1874. All diseases. Admitted.	1874. All diseases. Died.	1874. Yellow fever. Admitted.	1874. Yellow fever. Died.	1875. All diseases. Admitted.	1875. All diseases. Died.	1875. Yellow fever. Admitted.	1875. Yellow fever. Died.
1	Bahia Honda	....	....	....	....	....	....	....	....
2	Baracoa	308	7	0	0	876	5	0	0
3	Bayamo	6,434	240	38	18	3,594	163	4	0
4	Cabanas	....	....	....	....	....	....	....	....
5	Cardenas	....	....	....	....	....	....	....	....
6	Ciego de Avila	9,591	191	1	1	6,197	237	78	21
7	Cienfuegos	260	8	0	0	364	11	2	0
8	Cuba (Santiago de)	9,921	455	47	21	9,390	434	47	33
9	Gibara	2,693	112	6	2	1,908	140	22	10
10	Guanabacoa	....	....	....	....	....	....	....	....
11	Guanajay	....	....	....	....	....	....	....	....
12	Guantanamo	2,912	60	9	3	3,132	70	0	0
13	Güines	....	....	....	....	....	....	....	....
14, 15	Havana	9,400	856	338	189	14,723	1,348	907	328
16	Holguin	5,709	163	418	83	3,620	107	47	0
17	Isle de Pinos	326	23	0	0	542	61	0	0
18	Jaruco	....	....	....	....	....	....	....	....
19	Jiguani	755	51	2	1	357	12	0	0
20	Manzanillo	5,776	213	36	11	3,946	346	30	14
21	Mariel	....	....	....	....	....	....	....	....
22	Matanzas	324	11	22	5	830	88	59	30
23	Mayari	887	51	57	23	1,288	17	0	0
24	Moron	3,012	72	0	0	2,353	55	0	0
25	Nuevitas	5,703	173	8	0	3,089	130	1	1
26	Palma Soriano	1,517	78	4	2	759	34	2	0
27	Pinar del Rio	....	....	....	....	....	....	....	....
28	Puerto del Padre	655	10	0	0	857	17	3	0
29	Puerto Principe	25,306	1,019	308	138	12,462	702	46	41
30	Remedios	731	32	14	5	3,789	205	70	39
31	Sagua la Grande	....	....	....	....	....	....	....	....
32	San Antonio	....	....	....	....	....	....	....	....
33	Sancti Spiritus	3,204	161	32	26	7,572	523	498	294
34	Santa Clara	784	23	4	3	11,691	193	0	0
35	Santa Cruz del Sur	643	11	5	1	667	23	1	1
36	Santiago de las Vegas	....	....	....	....	....	....	....	....
37	Trinidad	1,551	43	1	1	3,482	44	1	0
38	Victoria de las Tunas	1,683	99	1	0	1,100	107	0	0
		100,080	4,162	1,351	483	96,538	5,022	1,813	812
	Of these there were in the wards of the Hospital de Madera, from January, 1870, to July, 1879	3,120	186	77	36	3,647	263	209	85
	And in San Ambrosio	6,280	670	261	153	11,076	1,085	696	243

TABLE No. 46—Continued.

Number.	City, town, or village.	1876. All diseases. Admitted.	1876. All diseases. Died.	1876. Yellow fever. Admitted.	1876. Yellow fever. Died.	1877. All diseases. Admitted.	1877. All diseases. Died.	1877. Yellow fever. Admitted.	1877. Yellow fever. Died.
1	Bahia Honda	....	....	....	....	....	....	....	....
2	Baracoa	2,492	301	252	189	1,780	304	265	156
3	Bayamo	3,240	178	0	0	4,118	269	0	0
4	Cabanas	....	....	....	....	....	....	....	....
5	Cardenas	....	....	....	....	....	....	....	....
6	Ciego de Avila	6,976	493	226	58	9,680	947	107	28
7	Cienfuegos	4,638	484	337	110	6,744	278	262	35
8	Cuba (Santiago de)	6,873	616	828	208	16,852	1,347	480	301
9	Gibara	2,148	241	205	128	5,203	633	386	258
10	Guanabacoa	....	....	....	....	....	....	....	....
11	Guanajay	....	....	....	....	....	....	....	....
12	Guantanamo	4,988	121	36	14	3,210	269	258	126
13	Güines	....	....	....	....	....	....	....	....
14, 15	Havana	22,345	1,683	1,361	719	23,176	3,001	1,289	799
16	Holguin	6,194	378	150	95	8,648	1,117	794	681
17	Isle de Pinos	638	58	0	0	837	17	0	0
18	Jaruco	....	....	....	....	....	....	....	....
19	Jiguani	523	22	3	0	1,227	83	4	1
20	Manzanillo	3,166	202	69	40	9,281	717	10	5
21	Mariel	....	....	....	....	....	....	....	....
22	Matanzas	8,588	300	212	62	4,583	243	4	2
23	Mayari	768	16	0	0	5,186	771	17	5
24	Moron	4,641	177	299	85	5,146	235	4	2
25	Nuevitas	2,210	116	94	48	5,108	501	109	66
26	Palma Soriano	908	40	4	1	1,972	82	0	0
27	Pinar del Rio	....	....	....	....	....	....	....	....
28	Puerto del Padre	1,344	33	5	0	1,653	61	0	0
29	Puerto Principe	12,926	643	463	211	17,442	1,084	681	262
30	Remedios	4,964	156	16	7	4,256	275	13	8
31	Sagua la Grande	....	....	....	....	....	....	....	....
32	San Antonio	....	....	....	....	....	....	....	....
33	Sancti Spiritus	10,165	804	454	378	11,653	787	309	267
34	Santa Clara	12,578	785	1,970	475	5,220	414	345	166
35	Santa Cruz del Sur	297	18	0	0	6,196	683	169	127
36	Santiago de las Vegas	2,523	49	56	21	5,084	218	0	0
37	Trinidad	4,063	74	17	13	4,320	346	65	47
38	Victoria de las Tunas	317	15	0	0	3,189	358	67	25
		180,508	7,998	6,557	2,857	171,714	14,985	5,583	3,262
	Of these there were in the wards of the Hospital de Madera, from January, 1870, to July, 1879	6,691	484	407	211	6,254	848	258	110
	And in San Ambrosio	15,654	1,199	954	508	16,922	2,158	981	669

TABLE No. 46—Continued.

Number.	City, town, or village.	1878.				1879. From January 1 to July 1—6 months.			
		All diseases.		Yellow fever.		All diseases.		Yellow fever.	
		Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.
1	Bahia Honda	......	......	......	......	......	......	......	......
2	Baracoa	1,527	94	30	4	150	7	1	0
3	Bayamo	3,255	367	13	9	701	115	5	3
4	Cabanas	......	......	......	......	......	......	......	......
5	Cardenas	......	......	......	......	......	......	......	......
6	Ciego de Avila	3,639	438	3	1	374	25	0	0
7	Cienfuegos	2,121	105	14	5	......	......	......	......
8	Cuba (Santiago de)	14,114	1,471	838	531	2,909	233	99	65
9	Gibara	3,118	195	59	37	564	19	1	1
10	Guanabacoa	......	......	......	......	......	......	......	......
11	Guanajay	......	......	......	......	......	......	......	......
12	Guantanamo	3,122	277	244	137	776	49	82	24
13	Güines	......	......	......	......	......	......	......	......
14, 15	Havana	24,301	2,887	1,150	746	6,890	496	432	198
16	Holguin	4,829	135	15	10	1,050	27	0	0
17	Isle de Pinos	622	17	0	0	75	7	0	0
18	Jaruco	......	......	......	......	......	......	......	......
19	Jiguani	2,038	68	4	2	......	......	......	......
20	Manzanillo	5,857	482	72	43	626	25	0	0
21	Mariel	......	......	......	......	......	......	......	......
22	Matanzas	2,589	216	299	188	......	......	......	......
23	Mayari	3,085	249	8	1	......	......	......	......
24	Moron	999	81	5	2	......	......	......	......
25	Nuevitas	2,546	300	58	81	......	......	......	......
26	Palma Soriano	1,938	223	175	54	......	......	......	......
27	Pinar del Rio	......	.....	......	......	......	......	......	......
28	Puerto del Padre	1,045	31	0	0	......	......	......	......
29	Puerto Principe	11,218	840	20	8	1,040	59	8	1
30	Remedios	2,168	100	4	3	350	20	0	0
31	Sagua la Grande	......	......	......	......	......	......	......	......
32	San Antonio	......	......	......	......	......	......	......	......
33	Sancti Spiritus	5,584	305	127	112	1,190	20	6	0
34	Santa Clara	3,866	181	42	10	1,148	26	0	0
35	Santa Cruz del Sur	1,208	249	0	0	......	......	......	......
36	Santiago de las Vegas	2,279	221	20	7	84	25	0	0
37	Trinidad	1,523	56	0	0	402	16	0	0
38	Victoria de las Tunas	2,506	192	3	0	......	......	......	......
		111,097	9,780	3,198	1,891	18,229	1,169	584	292
	*Of these there were in the wards of the Hospital de Madera, from January, 1870, to July, 1879	5,778	624	104	69	1,916	152	62	22
	And in San Ambrosio	18,523	2,263	1,046	677	4,974	344	370	176

*It deserves notice that the old San Ambrosio Hospital, constructed of stone masonry, is located, very unfavorably as to yellow fever, on the edge of the harbor, in a low, densely populated, and notoriously infected section of Havana, while the new Hospital de Madera, constructed of numerous detached and well-ventilated wooden frame wards, stands isolated from other buildings on the summit of the elevated Principe hill and is admirably located; and that during the nine and a half above-reported years (1870 to July, 1879) of the occupation of the latter, there died therein 342 in every 1,000 cases of yellow fever, while the number in San Ambrosio was, during the same time, 479 in every 1,000 cases.

TABLE No. 46—Continued.

Number.	City, town, or village.	Total all diseases.		Total yellow fever.	
		Admitted.	Died.	Admitted.	Died.
1	Bahia Honda	2,804	27	5	4
2	Baracoa	22,480	844	677	386
3	Bayamo	46,610	2,920	2,024	706
4	Cabanas	542	8	20	0
5	Cardenas	9,677	297	517	116
6	Ciego de Avila	51,371	3,090	999	335
7	Cienfuegos	23,727	1,193	1,588	337
8	Cuba (Santiago de)	175,627	10,237	7,337	3,390
9	Gibara	22,444	1,744	1,032	607
10	Guanabacoa	2,481	72	88	30
11	Guanajay	9,774	335	348	94
12	Guantanamo	32,914	1,553	1,020	506
13	Güines	3,249	126	145	50
14, 15	Havana	418,143	28,819	31,437	9,820
16	Holguin	55,795	3,024	3,603	1,534
17	Isle de Pinos	13,382	655	171	60
18	Jaruco	350	7	2	1
19	Jiguani	8,670	709	253	164
20	Manzanillo	50,106	3,532	1,638	691
21	Mariel	2,351	76	150	41
22	Matanzas	45,148	2,045	2,623	877
23	Mayari	14,421	1,222	165	60
24	Moron	24,449	1,060	906	294
25	Nuevitas	42,483	2,817	907	436
26	Palma Soriano	7,094	457	185	57
27	Pinar del Rio	11,612	478	708	194
28	Puerto del Padre	5,554	152	8	0
29	Puerto Principe	191,790	9,407	7,518	2,767
30	Remedios	24,370	1,398	1,034	431
31	Sagua la Grande	3,846	144	183	37
32	San Antonio	5,395	240	414	120
33	Saneti Spiritus	59,839	3,689	2,661	1,746
34	Santa Clara	65,576	2,830	3,748	1,150
35	Santa Cruz del Sur	17,828	1,379	645	287
36	Santiago de las Vegas	21,140	806	536	103
37	Trinidad	35,063	1,616	1,090	549
38	Victoria de las Tunas	29,395	2,233	610	365
		1,556,747	91,340	76,940	28,347

TABLE No. 47.—*Annual averages, for the five years* 1855–'59, *of the hospital statistics in Pezuela's Geor. Dict., vol.* 3, *p.* 419.

Jurisdictions.	CIVIL HOSPITALS.				MILITARY HOSPITALS.			
	All diseases.		Yellow fever.		All diseases.		Yellow fever.	
	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.
Bahia Honda	1,696	186	6	1	65	1	0	0
Baracoa	1,023	62	21	2	839	8	10	3
Bayamo	1,359	112	58	18	994	52	86	22
Bejucal	1,583	90	19	2				
Cabañas					31	1	1	1
Cardenas and Colon	7,800	276	121	25	408	11	24	5
Cienfuegos	1,302	61	64	9	410	7	26	3
Cuba	5,171	415	293	54	4,887	150	238	64
Gibara	323	17	13	4	33	1	8	1
Guanabacoa	2,182	83	21	5	278	9	12	3
Guanajay and Mariel	1,497	197	66	18	782	45	74	20
Guantanamo	1,943	148	47	10	832	9	11	2
Güines	3,480	146	43	13	396	22	30	12
Habana	33,447	3,304	5,136	1,300	16,966	1,002	1,834	492
Holguin	615	50	81	28	711	62	105	30

TABLE No. 47.—*Annual averages, for the five years* 1855–'59, *&c.*—Continued.

Jurisdictions.	Civil hospitals.				Military hospitals.			
	All diseases.		Yellow fever.		All diseases.		Yellow fever.	
	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.
Isle of Pines	1,238	93	13	6	950	35	23	7
Jaruco	506	34	0	0	101	4	8	3
Jiguani	340	26	0	0	....	....	....	....
Manzanillo	292	15	21	5	195	5	15	1
Matanzas	15,781	631	434	118	1,604	93	194	72
Nuevitas	198	20	16	4	224	16	15	4
Pinar del Rio	1,640	170	17	5	982	52	89	23
Puerto Principe	2,149	166	203	52	2,852	117	237	54
Remedios	2,855	171	80	25	[illegible]	26	53	17
Sagua	6,494	196	43	18	302	15	16	7
San Antonio	609	40	13	4	268	13	18	6
San Cristobal	451	22	2	0	...	....	....	....
Sancti Spiritus	380	64	5	4	656	22	51	13
Santa Clara	1,676	60	23	13	1,031	18	16	7
Santa Cruz	633	25	4	1	51	2	4	2
Santa Maria del Rosario	781	70	5	2	....	....	....	....
Santiago	833	91	15	2	700	13	47	6
Trinidad	5,273	155	160	42	934	50	58	17
Victoria de las Tunas	373	35	1	0	270	8	2	0
Totals	109,421	9,004	7,434	1,872	34,199	1,845	3,288	888
Totals of military hospitals	34,199	1,845	3,288	888				
Totals of civil and military hospitals	143,620	10,849	10,722	2,760				

CHAPTER XXVI.

SUMMARY OF THE SUCCEEDING SPECIAL REPORTS RELATIVE TO FORTY-NINE SPECIAL PLACES IN CUBA.

The following special reports of forty-nine localities in Cuba include all cities and towns which, in 1862, had a population exceeding 3,070, and in addition a number of less populous places, which are of interest because of their importance, military, commercial or otherwise. All facts of interest concerning the sanitary condition and prevalence of yellow fever in these places are very certainly not reported, but all desirable facts which could be procured from reliable sources are reported.

For convenience of reference the various places are recorded in alphabetical order, which, however, is not as instructive a mode for their study as by order of localities. Hence it will be well to give a classification of these forty-nine places, based on their location, in the six provinces of Cuba, proceeding from west to east, and whether on the sea-shore or inland.

PROVINCE OF PINAR DEL RIO.

The following six places are reported, viz: Bahia Honda, Cabañas, and Mariel, on the northern sea-coast, and Guanajay, Pinar del Rio, and San Cristobal, located inland. This last province suffers comparatively little with yellow fever.

PROVINCE OF HABANA.

The following thirteen places are reported, viz: Batabano and the Isle of Pines, on the southern coast, and Havana and Regla on the northern coast. The following nine are inland towns: Bejucal, Guanabacoa, Güines, Jaruco, Marianao, San Antonio, San José de las Lajas, Santa Maria del Rosario, and Santiago de las Vegas. The Isle of Pines suffers remarkably little with yellow fever.

PROVINCE OF MATANZAS.

Four places are reported, viz: Cardeñas and Matanzas, on the northern coast, and Colon and San Miguel inland.

PROVINCE OF SANTA CLARA.

Eight places are reported, viz: Caibarien and Sagua la Grande on the northern sea-coast, and Cienfuegos, Trinidad and Zaza, on the southern coast; Remedios, Sancti Spiritus, and Santa Clara are inland.

PROVINCE OF PUERTO PRINCIPE.

Four places are reported, viz: Nuevitas, on the north, and Santa Cruz on the south coast; Ciego de Avila and Puerto Principe, inland.

PROVINCE OF CUBA.

Fourteen places are reported, viz: Baracoa, Gibara, and Puerto Padre, on the north, and Cuba, Guantanamo, and Manzanillo, on the south coast, while Bayamo, Cobre, Holguin, Jiguani, Mayari, Moron, Palma-Soriano, and Victoria de las Tunas are inland.

Of the total forty-nine places twenty-eight are located inland, while twenty-two are on the sea-coast, and of these fifteen are ports of entry.

In connection with these forty-nine places information is given in respect to other places adjacent to these, and especially in respect to the following fourteen towns, viz: Baga, Banao, Cifuentes, Cruces, Consolacion del Sur, Isabela de Sagua, Mayajigua, Palmira, Recreo, Sabana, San Miguel de Nuevitas, Santo Domingo, Tanamo and Tiguaboa. References to these places will be found in the index. Some information respecting the prevalence of yellow fever is thus presented in regard to sixty-three places in Cuba.

CHAPTER XXVII.

BAHIA HONDA.

This town, founded in 1779, is in the province of Pinar del Rio, and about 55 miles west of Havana. It is 50 feet above the level of the sea, and is "ill ventilated because surrounded by hills." It is located 2 miles south of the harbor of Bahia Honda, which is one of Cuba's 15 harbors of the first class. Its largest dimensions are about 5 miles length by 3 miles width, and it is the most western of Cuban harbors of the first class. It has no port of entry. This town, the chief one in the jurisdiction, had in 1862 a population of 715. Reports were received (1879) from Dr. J. J. Rabeiro, of the local board of health, and from the mayor through the Spanish Commission. These reports stated the population and deaths as follows:

TABLE No. 48.

	Population.	Deaths.	Resulting death-rate per 1,000 population.
Whites	474	22	46.41
Colored	276	47	170.29
Total	750	69	92.00

Number of houses, 102.

The population was for 1877; the deaths may have been for 1878.

The above reports concur in stating that "yellow fever is thus far unknown, is disowned, and is neither indigenous nor imported." It is further stated that occasional cases have occurred in Spaniards, residents for some time of Bahia Honda, and also in natives on visiting Havana; that there is only one company of soldiers stationed there, and that the only unacclimated residents are a few young Spaniards, and that adjacent populations do not suffer from yellow fever, because, as is believed, there is neither yellow-fever poison nor unacclimated material for the poison in this neighborhood.

Pezuela's statistics, Table No. 47, report no cases of yellow fever in the military hospitals, but an annual average of six cases in the civil hospital during the five years,

1855-'59. The military hospital statistics, Table No. 46, indicate that Bahia Honda had no military hospital, except during the fifteen years, 1858-1872. During this time, although there were 2,084 admissions by all diseases, yet of these only five were cases of yellow fever, and all occurred in 1870. This remarkable exemption of Bahia Honda from yellow fever was attributed by Dr. Pardiñas, medical director of military hospitals at Havana, to "the smallness of the garrison, composed generally of acclimated soldiers."

The absence of yellow fever from Bahia Honda, in both the military and civil population, deserves special notice, because it is a sea-port, and because many have taught that sea-ports are, *per se*, the special habitats of yellow fever. It is significant, that this sea-port is not a port of entry, therefore has no commerce, and it has no railroad. Its limited commercial intercourse with infected places is undoubtedly the most important fact in explanation of its freedom from yellow fever.

CHAPTER XXVIII.

BARACOA.

This city, founded in 1512, was the first settlement made by the Spaniards in Cuba. It is in the province of Cuba or Santiago de Cuba; and, as Bahia Honda is the most western, so Baracoa is the most eastern sea-port of any note on the island. Both are on the north coast, and distant, by road, 852 miles. Baracoa is elevated 21 feet above the level of the sea at low-tide.

It is a port of entry, about the sixth in importance in Cuba, and the most important port of the fruit trade. A tri-monthly line of steamships touch at this place, establishing communication with the chief northern ports, and also with the southern port of Santiago de Cuba. It has a small circular-shaped harbor, less than a mile in diameter, and of "the first class."

Reports were received from Dr. Pedro Imanes, the mayor, through the Spanish Commission, and from Mr. A. M. Zamora, United States vice commercial agent at Baracoa. In 1862 the civil population was 2,634, and Dr. Imanes reported it to have been, in 1877, 5,095, viz, 3,031 whites and 2,064 colored. The deaths have been as follows in the civil population:

TABLE NO. 49.

Year.	White.	Colored.	Total.	Remarks.
1873	75	109	184	
1874	70	92	162	
1875	106	101	207	
1876	269	299	568	Small-pox and yellow fever.
1877	131	105	236	Or 43.62 per 1,000 population.
1878	90	118	208	
Seven months to July 31, 1879	54	55		

The annual average death-rates for the two years 1877 and 1878, are 36.6 for the whites, 53.7 for the colored, and 43.5 for the total population.

Dr. Imanes states: "It must not be forgotton that many country people are buried in the cemetery of Baracoa, thereby increasing unfavorably its apparent death-rate."

"The hygienic condition of the town has improved, but ponds and marshes lie to seaward and remain to be yet filled up in order to rid us of marsh poison. The lowlands are very unheathy, but the adjacent mountains and table-lands are remarkably healthy. Malarial fevers especially prevail, and at times dysentery, malarial cachexia and pernicious malarial fever are frequent."

YELLOW FEVER.

Dr. Imanes reported as follows:

"About fifty years ago an epidemic of yellow fever is said to have occurred here. However, the records of the board of health give no evidence of any epidemic until 1876. I came here early in 1874, and saw no cases of yellow fever in either foreign sailors, Europeans, or natives until 1876. It began in July and continued with varying intensity until the middle of 1878." [The military hospital statistics show that this epidemic began in May, 1876, and continued until September, 1878.] "The disease was imported in 1876 by the gunboat Ericsson; the sick of this vessel were sent

to the military hospital, from whence the disease spread to the troops. From this hospital the disease also spread to the jail, and from thence to the town. It attacked by preference natives, who were anemic and weakened by malaria. There were many Europeans in town, of whom many were acclimated, but of those unacclimated few were attacked, and these so mildly that not one died.

"Another exceptional feature of this epidemic was that it attacked with special vigor and fatality native Cubans, due probably to their anemia, malarial cachexia and bad hygienic conditions, all so common in this country. Not only country people, temporarily visiting Baracoa, but natives of the city were attacked. In the surrounding country some few families were infected, and the inland village of Sabana—the only adjacent settlement of any note, remarkable for its salubrity, 9 miles to the southeast of Baracoa, and at considerable elevation above the sea—was afflicted with an epidemic of yellow fever.

"The third remarkable trait of this epidemic was its markedly contagious character. Seldom was one member of a family attacked without being followed by attacks of other persons in the same house; and the disease especially prevailed in the most elevated parts of the town, where are located the military hospital and the jail, while the portion of the town along the shore—the lowest and most insanitary part and separated from the elevated part—was exempt from the disease.

"Excepting in 1876–'78, the records of the board of health show very few cases since 1840; and, I believe, that these few cases were in those who, arriving from Havana or Santiago de Cuba, had there been poisoned. Of sailors arriving here, I have known of only one or two fatal cases of yellow fever, and with one exception the disease was probably contracted in Hayti or in Porto Rico.

"I do not believe that yellow fever is either endemic in or indigenous to Baracoa, which has suffered with only two yellow-fever epidemics. There are always some unacclimated persons here; and the natives living in the adjacent elevated country are, as is well known, as liable as Europeans to yellow fever; yet these, on visiting Baracoa, except in 1876–'78, are not attacked. The number of foreign residents is considerable, and from 100 to 200 American vessels, which average a crew of five to six men to each vessel, visit Baracoa annually; yet I have not seen in such crews a single case of yellow fever, which could be said to have originated here."

Mr. Zamora reported: "Yellow fever is supposed to be indigenous here, but, at times, we do not hear of it for years, and the only time it ever existed as an epidemic was in 1876–78, when imported by the Spanish gunboat Ericsson. The few cases which do occur are from June to October. Tanamo is the nearest adjacent town of note; it has a small population; there are few Europeans there, and yellow fever is unknown. The temperature here is 84° F. in summer, and 76° in winter."

Tanamo is an inland town, which in 1862 had 436 population; it is about 6 miles from the northern coast, on the Sagua de Tanamo River, and about 50 miles northwest of Baracoa.

Turning from the above reports to those of the military hospital statistics, Table No. 46, it will be seen that these report, during 10 of the 28 years, 1851–1878, not one case of yellow fever at Baracoa; during 10 more years, only from one to six cases; and in no year more than thirty-one cases, except during the disastrous years 1876 and 1877, when military necessities forced an unusual number of troops to Baracoa. The large number of annual admissions by all diseases, compared with the very small number of yellow-fever cases, prove that this disease has not become domiciliated at Baracoa.

It is to be remembered that Baracoa has no railroad, and is comparatively commercially isolated from habitually infected ports. The little prevalence of yellow fever is certainly not due to any lack of salt water and air, nor to lack of swamps and other insanitary conditions, nor to climatic peculiarities, nor to any deficiency of unacclimated population, which Mr. Zamora estimates at about 500.

CHAPTER XXIX.

BATABANO.

This town, founded, says Pezuela, in the middle of the eighteenth century, is in the province of Havana, 33 miles (or 55 kilometers) directly south of Havana, with which it has been connected by railroad since 1843. It is located directly on the sea-shore, on a low, marshy, ill-drained flat, only about 3 feet above the level of the sea. It is a filthy, repulsive-looking place, containing a superabundance of materials for decomposition and putrefaction. Buzzards abound on the house-tops. Swamps are plentiful, and Humboldt says, correctly, "Nothing can be more gloomy than the aspect of these marshes around Batabano." Pezuela states that in consequence of these marshes it is a very unhealthy locality. In front of the town is the shallow, open sea. It has

no harbor, is not a port of entry, and is commercially of no importance, except as the connecting link between the railroad from Havana and two steamship lines, one passing, perhaps once a week, to the Isle of Pines, and another about twice a week to the southern ports from Cienfuegos to Santiago de Cuba. About a dozen little fishing-smacks were to be seen at anchor. The census of 1862 states that the population was 877. It may be now 1,000, although I failed to count even 100 houses while delayed in the cars en route to Havana.

Dr. José M. Campos, through the Spanish Commission, reported as follows: "The average annual deaths are about 50 citizens and 30 sailors"; but, as Dr. Campos neglects to state either the population, or how many of these "sailors" are residents, the death-rate cannot be accurately determined. However, preceding facts indicate that it is certainly not less than 50 per 1,000 population, and may be even 80.

Dr. Campos also reports that yellow fever is "indigenous" to Batabano; that there are about 200 unacclimated people in the place; that the disease has never been prevalent; and that during the past six years there have been only six fatal cases of yellow fever, three citizens and three sailors.

Dr. Campos states that the annual range of temperature is from 18° C. (64°.4 F.) to 33° (91°.4 F.); the minimum observation was 16° C. (60°.8 F.); and that the range of the barometer is from 760 milimeters (29.9 inches) to 765 milimeters (30.1 inches), the maximum being 768 milimeters (30.2 inches).

The statements as to yellow fever are too few and unsatisfactory to justify any conclusions.

CHAPTER XXX.

BAYAMO.

This city is one of the oldest in Cuba, having been founded prior to 1551. It is in the province of Cuba, about 25 miles inland from and east of the sea-port of Manzanillo, and on the high road from this place to Santiago de Cuba, being about 80 miles northwest of this city.

The population in 1862 was 6,119, viz, 2,303 whites and 3,816 colored; these lived in 1,223 houses. The population in 1877 is reported to have been 7,886.

Peñuela, writing in 1854, specifies the prevailing diseases, malarial fever being the chief disease, but he does not include yellow fever, which he reports did prevail as an epidemic in 1837.

The military hospital statistics, Table No. 46, for the 28 years 1851–1878, show not one case of yellow fever during ten of these years, and less than 38 cases during ten other years. The soldiers suffered much in 1859, 1869–'70; very severely in 1872 and 1873, but not at all in 1876 and 1877. These facts, in connection with the following, are instructive: Manzanillo is the sea-port of Bayamo, and the prevalence of yellow fever at Bayamo corresponds with the prevalence of yellow fever at Manzanillo and not at other places. In 1876, 1877, Cienfuegos, Santiago de Cuba, Baracoa, and many places in Cuba suffered severely with yellow fever, but Manzanillo had little and Bayamo had none, although many soldiers were there, since there were over 7,000 admissions by all diseases in the military hospital during these two years.

The military hospital statistics illustrate also, that which these same statistics repeatedly illustrate as to many other places, viz, that something more is needed even in Cuba, than mere aggregations of men to cause yellow fever; for instance, in 1868, there were only 316 admissions by all diseases, and yet 53 of these admissions were cases of yellow fever, while in 1877 there were 4,118 admissions, and yet not one case of yellow fever.

CHAPTER XXXI.

BEJUCAL.

This city, founded in 1710, is in the province of Havana, 17 miles south of the city of Havana, and on the railroad to Batabano. It is about 300 feet above the sea, located at the foot of a chain of hills, and at the summit of some of these the Morro light at Havana can be seen. Pezuela reports that the longevity of its inhabitants is remarkable, as also the beneficial influence which its healthy air exercises on the invalids who visit the place. Traversing the city in the cars my notes read, "Bejucal is characterized by the same small one-story buildings, dirty mud-streets, low floors on a level with these streets, filthy surroundings, and wretched palm-huts in the outskirts, which characterize other towns of Cuba."

Dr. F. Rodriguez Olivera reported, through the Spanish Commission, as follows: "A stream surrounds the town, which, though full in the rainy season, consists, during a greater part of the year, chiefly of pools, each constituting a focus of swamp-poison. Hence the location is very damp, and malarial fevers of every form prevail." In 1862 the population was 3,485; "in 1877 it was 7,008, viz: 5,525 whites and 1,483 colored; the deaths in 1878 were 130 whites and 50 colored; and for the first eight months of 1879 to August 28, the deaths were 94 whites and 35 colored." The death-rates for 1878 were, then, for the whites 23.5, for the colored 33.7, and for the total population 25.7 per 1,000 population.

Dr. Olivera further reported as to

YELLOW FEVER.

"During the past eight years this disease has certainly not prevailed, and according to the oldest inhabitants has never prevailed. Some years there are no cases of yellow fever here, and never more than 15 to 20 cases; these are always of new arrivals, for, although some assert that natives have been attacked here, this is an error, since their disease was serious bilious fever. The few cases observed here have generally been among those engaged in commerce, hence traveling constantly between Havana and this place, and therefore probably infected outside of Bejucal. The disease is imported. The number of unacclimated population is very limited; almost all Spaniards who reside here have had the disease in other localities."

This last observation is valuable, and applicable to most small towns in Cuba. It should not be forgotten that the vast majority of unacclimated foreign-born residents of Cuba are Spaniards, and that these have generally passed some time in Havana or other infected sea-ports before migrating to inland towns.

Dr. Pedro Rou also reported through the Spanish Commission, and takes a different view from Dr. Olivera. He says: "Very few cases of yellow fever occur here, and these are civilians, since there are no sailors and very few soldiers here. The disease is 'indigenous to this place,' and has not been observed to have been imported from elsewhere. Our few cases have occurred equally among those who have never left' the place, and among those coming from localities where yellow fever prevailed."

It is also reported that only occasional cases occur in the towns adjacent to Bejucal, caused either by absence therefrom of yellow-fever poison or by the limited number of their unacclimated population.

Pezuela's statistics, Table No. 47, show that from 1855 to 1859 there was in the civil hospital of Bejucal an annual average of 19 cases of yellow fever.

CHAPTER XXXII.

CABAÑAS.

This town, founded in 1818, is in the province of Pinar del Rio. It is on the north coast, about 38 miles west of Havana, and between Mariel and Bahia Honda. It is located on the east bank of the harbor of Cabañas, a harbor of the "second class," of which the dimensions are about 4 by 7 miles. It is not a port of entry; in 1862 it had a population of only 565, and is a place of no importance commercially or otherwise. No information was reported or procured respecting this place except in Table No. 46 of military hospital statistics. These embrace only the eight years 1860–'67, during which time, as will be seen by reference to said statistical report, there were no cases of yellow fever in any of said years, except in 1865, when there were 20 cases.

Peznela's statistics 1855–'59, Table No. 47, show the absence of yellow fever during these years in the civil hospital.

These facts seem to prove that yellow fever has no peculiar fondness for this place, destitute of commercial importance, notwithstanding the fact that it is a sea-port.

CHAPTER XXXIII.

CAIBARIEN.

This town, founded in 1822, is in the province of Santa Clara; it is on the north coast, about midway the length of the island. It is specially notable because the seventh in importance of the Cuban ports of entry, and the sea-port of the large

inland town of Remedios. It is located on a former mangrove swamp at the mouth of the Caibarien River, and is only about 8 feet above the level of the sea, while its environs are not more than 10 feet. Pezuela states that, notwithstanding its unfavorable location, it "is quite a healthy place."

A railroad runs from Caibarien southwest to San Andres viâ Remedios, the distance to Remedios being 5¾ miles (9 kilometers), and to San Andres, 28¾ miles (46 kilometers.) A steamship line connects it once a week with Cardeñas. It has no harbor, and so shallow a roadstead that vessels anchor at the key or little island of Frances, some 25 miles northeast of Caibarien.

POPULATION AND DEATH-RATE.

In 1862 the population was 1,878. Through the Spanish Commission the mayor reported* that the population in 1877 was 5,670, viz: 4,800 whites and 870 colored; that the annual deaths were usually 100 to 130 whites, and 30 to 40 colored; and that the deaths in 1878 were 167, viz: 137 whites and 30 colored. Hence, the death-rates in 1878 were for the whites 28.5, for the colored 34.5, and for the total population 29.4.

YELLOW FEVER.

The mayor reported: "Yellow fever is not indigenous to Caibarien; it occurs but rarely, and then from June to September. Those who are chiefly attacked are recently arrived Spaniards and foreigners, who do not annually exceed 30 to 40. It very seldom attacks the native residents of Caibarien, but some natives from the country adjacent have been attacked on visiting this town. The disease occurs in almost all neighboring towns in the same way as at Caibarien. This town is not a garrison for troops, but of transit to Remedios, hence there are no cases of yellow fever here among soldiers."

Dr. Antonio Lopez reported similarly, and that "this port has been free from this endemic, yellow fever, during the last four years. In 1879 not one case occurred."

Mr. José G. Fuentes, United States acting commercial agent, reported in August, 1879, that "the doctors here dispute whether yellow fever is indigenous or imported. The disease occurs only in certain years; it prevailed in 1856 because of the presence of four companies of unacclimated soldiers; in 1870 it again prevailed because families living in the country fled for refuge from the insurrection to this place. In 1874 there were only six cases; in 1878 there was only one death; and in 1879 there have been none; not a case on any vessel; and the port has remained free of yellow fever, and of other contagious diseases. Persons born and resident in country towns have had yellow fever on visiting Cardeñas. In 1870 native Cubans from places 500 to 1,000 feet high suffered severely with yellow fever on visiting Remedios.

Mr. Fuentes further reported that the village of "Mayajigua did not suffer with yellow fever until the war, 1873, 1874, and 1875, when many died on the coast." Mayajigua is an inland town about 12 miles from the north coast, and 20 miles southeast of Caibarien. Its population was 313 in 1862. It is reported to be located on very high ground, perfectly ventilated, and therefore very healthy. It has a mineral spring of note, of which Humboldt says, "The water of this spring has a very great local reputation; it presents the phenomenon of being about 15° warmer in the morning and evening than at other hours."

CHAPTER XXXIV.

CARDEÑAS.

The town or "villa" of Cardeñas is in the province of Matanzas. It "was only settled in 1828, but is now one of the most flourishing towns on the island, owing, it is said, to the large number of Americans who are engaged in business there, and who form a large proportion of the mercantile community." It is located directly on the harbor, or rather the Bay of Cardeñas, and is now the third port of entry of importance in Cuba, ranking after Havana and Matanzas. It is 25 miles due east of Matanzas; however, by railroad, the distance is double this. Two railroads diverge from it, one proceeds 18 miles due south to Bemba, connecting there with the main railroad system of the island, which links Cardeñas to Havana, Matanzas, Sagua, Cienfuegos,

* It may be here stated, once for all, that the various reports of "mayors, through the Spanish Commission," appointed by the governor-general of Cuba to aid the United States-Havana Yellow Fever Commission, were in the main really prepared by the chief physicians of each place, appointed by the mayor for this special purpose.

&c.; the other railroad passes to the southeast, crosses the main trunk line at Colon, and terminates at Calimente, 52 miles (84 kilometers) distant, and about half way to Cienfuegos, the point of destination. On this latter road the inland town of Recreo, to be referred to, is located, about 14 miles from Cardeñas.

Cardeñas was personally inspected, and, though the board of health was found destitute of records, the following facts were obtained:

LOCATION.

The town is only about seven blocks in width, extending from the wharves some twenty blocks inland to the southwest. One-third of this length is flanked on each side by a mangrove swamp, either boggy or covered with water. The original site was a mangrove swamp. From the wharves, and between the present lateral swamps, the ground gradually rises from 3 feet to 12 feet above the sea. However, the center of population is only about 4 feet above the sea, so that a very large part of the population live on ground within 4 feet or less of subsoil water. Privy contents rise and fall with the tide. The surface soil varies in thickness, but in a considerable extent of the town is not more than a foot and a half in thickness, and rests on foundation-rocks of coral limestone.

DRAINAGE.

This is very bad. More than twenty houses of the poor working class were inspected at random, and not one was found in which the back yard was not either muddy or contained stagnant water. Houses were repeatedly seen where the water in the street gutters flowed back into the house drains. Crab-holes and crabs abound in the streets; a dozen crabs were seen in a half hour's walk; and within three blocks of the central plaza an enterprising three-feet native, costumed as was Adam before shame forced the fig-leaf on him, was training a crab harnessed to a sardine box.

WATER SUPPLY.

Since about 1872 Cardeñas has had an aqueduct which supplies water from a subterranean river one mile distant from the town. This affords an abundant supply at a cost of $3, gold, per month, for one faucet. The result of this charge is that, of 2,289 houses, only about 600 were reported to be supplied with this water. Well water is brackish and not potable; some houses have, under the flags of the court-yard, underground cisterns, but in Cardeñas, as in other Cuban towns, the poor for the most part purchase their water from street-carriers.

STREETS.

The streets, broad, straight, crossing each other at right angles, are about 40 feet wide, including sidewalks on each side 3 to 4 feet wide. After habituation to Havana, these streets appear very spacious. They are not paved, but macadamized, and are ill-drained.

HOUSES.

These, as everywhere else in Cuba, are very rarely more than one story high. They are built of stone generally, and not of rubble masonry, as in Havana and Matanzas. There are more wooden frame houses and plank floors than in Matanzas, which has more of these than Havana, and the houses generally occupy more space, and are better ventilated.

As throughout Cuba, ventilation between the ground and the lowest floor is very rarely found, all floors resting directly on the ground; some are a few inches above the level of the sidewalks, many are on a level therewith, and not a few are below even the level of the street. An American carpenter, an old resident, reported that, if the flooring of the houses in a very large part of the town was removed, an iron rod could be readily pressed through the soft mud beneath down to the foundation rocks. In a large part of Cardeñas a soil-moisture mark is to be seen, high up on the walls of the houses. Quartered in one of the very best houses in this town, I found my bed-room door within 10 feet of a vast excavation for the contents of the privy, which had not been emptied for ten years. In Cardeñas, as everywhere in Cuba, the privy system is the same, always as defective, foul and revolting as possible.

HARBOR.

The Bay of Cardeñas is 12 miles long by 18 wide. Near the shore it is so shallow that the anchorage ground is from three-fourths to two miles distant from the

shore, and yet the average tonnage of vessels visiting this port is only from 300 to 500 tons. American vessels remain at the anchorage, generally distant at least a mile, except in very rare instances. There are about 25 wharves, 60 to 200 feet distant from each other, and extending 100 to 300 yards from the shore into the water. At the end of these wharves a depth of 8 to 10 feet of water is found. These wharves are chiefly used by coast-traders and lighters.

BALLAST.

This is obtained from vessels arriving in ballast, and consists chiefly of hard, dense rock, mixed with some sand. This ballast is stored along the water-front, near the wharves, remaining thus deposited until needed, which is especially from May to October, and by vessels bound to southern ports of the United States.

POPULATION.

In 1846, eighteen years after its settlement, Cardeñas had 3,103 population, 310 houses, 1 cistern, and 45 wells, according to the census.

TABLE No. 50.

Census of—	Whites.	Asiatics.	Colored.	Males.	Females.	Total population.	Number of houses.
1862	7,628	....	3,257	....	....	10,885	1,192
1877	11,252	2,042	4,490	10,473	7,311	17,784	2,289

The census of 1862 does not specify the sexes, nor the number of Asiatics or Chinese, but in all such cases Cuban statistics include the latter with the whites. Of the 7,311 female population in 1877, 4,933 were white and 2,378 colored.

TABLE No. 51.—*Baptisms or births.*

Year.	White.	Colored.	Total.
1877	453	145	598
1878	410	147	557

DEATHS.

TABLE No. 52.—*Mortality statistics from the church register.*

Year.	White.	Asiatics.	Colored.	Total deaths.	Year.	White.	Asiatics.	Colored.	Total deaths.
1858	841	....	455	1,296	1870	547	25	363	935
1859	336	10	305	641	1871	655	4	329	988
1860	374	5	385	764	1872	247	4	161	412
1861	526	6	305	837	1873	386	82	182	650
1862	339	5	206	550	1874	394	51	269	714
1863	304	11	206	521	1875	366	28	218	612
1864	261	1	111	373	1876	666	70	322	1,058
1865	414	1	135	550	1877	340	44	192	576
1866	302	9	153	464	1878	223	59	189	471
1867	367	106	241	714	Eight months to August 30, 1879.	309	20	141	479
1868	374	20	255	649					
1869	336	31	133	500					

DEATH-RATE.

Taking the population of 1862 and of 1877 and the annual average deaths for the three years 1861-'62-'63, and 1876-'77-'78, the death-rates would be—

TABLE No. 53.

Years.	White.	Asiatics.	Colored.	Total.
1861-'62-'63	51.12	....	73.38	58.43
1876-'77-'78	36.52	27.40	52.11	39.47

N. B.—The compartively small Chinese death-rate is probably due to this population consisting solely of male adults, therefore the above death-rate is really very high.

YELLOW FEVER.

An American gentleman, long resident in Cuba, testified that yellow fever had prevailed annually in Cardeñas, certainly since 1836. Peñuela states that yellow fever prevails some years, and especially the year when he wrote, 1854. Drs. Dumont and Elcid reported in vol. 8 of the Anales that Cardeñas suffered severely in 1865, and that Recreo, an inland village 14 miles distant by railroad, suffered in 1858, 1862, and 1865. Mr. J. H. Washington, United States acting commercial agent, reported in 1879 that "the mild form of yellow fever, called the acclimating fever, exists at Cardeñas in all years and at all seasons"; that yellow fever is considered indigenous to all Cuban ports; that the doctors call many cases of bilious remittent fever of typhoid type yellow fever; and that in 1869 or 1870 many families from the country came to Cardeñas because of the war and some suffered with yellow fever.

The mayor reported through the Spanish Commission that "this endemic disease appears spontaneously as soon as commerce crowds the town with the unacclimated. From 1850 to 1869, this population was greatly increased by immigrants, but since 1869, owing to the insurrection, there has been less increase of strangers, and almost none during the last three or four years. The disease was severe in 1871, also in 1874; and 1879 has been the most fatal year ever known, to both soldiers and civilians, but though so severe on land hardly any have been attacked in the harbor. In the small towns, villages, and plantations adjacent to Cardeñas, there is no absolute immunity from yellow fever, since cases usually mild do occur. Sometimes four or five years pass without the arrival of any foreigners at these small adjacent towns," &c.

This evidence of the mayor in respect to the severity of the disease in 1879 on land, with exemption of the shipping, was confirmed by every one, some stating that at Cardeñas the vessels at anchor never suffer with yellow fever. There can be no doubt that this is comparatively if not wholly true, and due to the great distance from the shore at which the vessels anchor. In addition it should be remembered that generally the captains of all unacclimated crews at infected ports use every effort to keep their men on board, and that this is more readily effected the more distant the vessel is anchored from the shore.

Mr. Washington, United States commercial agent, reported August 8, 1879, "up to the present time there has been only one case of sickness in this harbor, viz, one seaman, shipped in Havana, on the brig Etolan of Philadelphia. The health of the shipping has been exceptionally good this year. In the city, however, there have been more cases of yellow fever and of typhus (?) than I have known during the four years I have been here. By far the greater part of the mortality has been among the troops stationed in the town and among the recent immigrants from Spain. It has raged very badly among them, and it is reported that about sixty soldiers and one hundred and thirty citizens have died of fever this year."

From the army surgeon at Cardeñas I procured the following facts, September 1, 1879. The military hospital at Cardeñas was closed in 1871, and not reopened, until 1879. The garrison consisted of 580 soldiers, of whom about 180 were acclimated; of the remaining 400 there were 204 attacked and 72 died, viz: In June, 80 admitted, 38 died; in July, 100 admitted, 29 died; and in August, 24 admitted, 5 died—this decrease in August having been due to removal of the troops from the town.

Among my own notes of inspection I find the following: "Among civilians the greatest number of deaths have occurred in the part of the town farthest from the wharves and from the mangrove swamps, where are the fewest stores, the largest number of the poor, and the greatest number of unacclimated Spaniards. The insanitary conditions of this specially infected district are apparently no worse than in other parts of the town."

In September, 1879, the Cronica Med. Quir. of Havana published the following pertinent facts: "Beside the ravages of the endemic [yellow fever], *bilious fevers have had victims, especially among children and youths.* These *bilious fevers* have occurred in the highest and healthiest district of the city, where the military infirmary has been established. Proper consideration for the welfare of the community would not have permitted such a location of this infirmary, however high the consideration due to sick soldiers. The object of this article is to call the attention of the government to and to protest against the establishment of this infirmary in a house located in the center of the most healthy ward in Cardeñas."

For further information as to the prevalence of yellow fever in Cardeñas, the military hospital statistics, Table No. 46, can be consulted. These embrace only the nineteen years 1852–'70. During three of these years there were no cases of yellow fever; during nine years there were only from 1 to 16 cases, and the disease most prevailed in 1854, 1858, 1864–'65, and 1868–'69. These statistics again show that there may be plenty of material without causing yellow fever, for in 1864 of only 317 admissions by all diseases there were 43 cases of yellow fever, while in 1853 there were 600 admissions without one case; and in 1866 there were 845 admissions with only one case of yellow fever. Comparing these military hospital statistics with those from the civil hospital, now to be presented, it will also be seen that the former cannot be taken as an infallible guide as to the prevalence of the disease; for while in 1866 the military hospital had only one patient with yellow fever out of 845 admitted, the civil hospital had 14 out of only 213 admissions. Of course, it should not be forgotten that the larger part of a population do not go to either the military or the civil hospital, and therefore that their cases of yellow fever go unrecorded.

TABLE No. 54.—*Annual statistics of the civil hospital at Cardeñas, compiled from the official monthly statistics for the sixteen years and eight months, January, 1863, to September, 1879.*

Years.	All diseases.		Yellow fever.		Years.	All diseases.		Yellow fever.	
	Admitted.	Died.	Admitted.	Died.		Admitted.	Died.	Admitted.	Died.
1863	158	8	6	2	1873	417	21	15	4
1864	192	21	9	3	1874	315	41	16	3
1865	239	28	21	3	1875	361	56	14	4
1866	213	16	14	4	1876	401	47	15	4
1867	208	19	14	3	1877	453	63	16	4
1868	206	15	6	1	1878	499	43	6	3
1869	163	13	13	3	1879, first eight months	556	78	146	48
1870	246	17	15	4					
1871	397	39	19	4	Totals	5,230	542	353	99
1872	206	17	8	2					

Of the above 5,230 total admissions, 1,075 were "colored and Chinese," among whom only one case and death of yellow fever is reported; this in 1865.

With rare exceptions, the greatest mortality during each year by all diseases occurred during the six months, May to October, and by yellow fever during the three months, June, July, and August.

The only frost known to the oldest inhabitants of Cardeñas was on Christmas eve, 1856.

CHAPTER XXXV.

CIEGO DE AVILA.

This village is in the province of Puerto Principe, is about 25 miles inland from the southern sea coast, and is on the high road from Sancti Spiritus to the city of Puerto Principe, being about 40 miles east of the former and 65 miles west of the latter. Pezuela states that it is a damp, unhealthy place, and suffers with intermittents during the rainy season. In 1862 its population was 511. No information was procured of this place, except that contained in the military hospital statistics, Table No. 46. These indicate that during the insurrection, this place became an important military post, the annual admissions exceeding 9,000 in two of the ten years reported, 1869–1878. In 1873 with 3,480 admissions there was no case of yellow fever, and in 1874 only one case in 9,591 admissions.

It is farther observable that the nearest large towns of importance are Sancti Spiritus and Puerto Principe, and that the soldiers in Ciego de Avila suffered most severely in 1871, while at Puerto Principe they suffered much in 1869, 1870, and 1871, and at Sancti Spiritus in 1869, 1870. At Ciego de Avila they again suffered severely in 1876, 1877, years when they also suffered severely at both Sancti Spiritus and Puerto Principe.

CHAPTER XXXVI.

CIENFUEGOS.

Cienfuegos, literally "hundred fires," was founded in 1819, destroyed by a hurricane, and rebuilt in 1825. It is in the province of Santa Clara, and 189 miles (305 kilometers) southeast of the harbor of Havana, by railroad, whereby it is united to the main railroad system of the island. It is located on the east side, and about midway the length of the harbor or bay of Jagua, which Las Casas called "the most magnificent port in the world," and it certainly is one of the most beautiful. Cienfuegos is, commercially, the most important port of entry on the southern coast, and, ranking with Sagua, is the fourth or fifth port in importance in Cuba. This place was personally inspected, and, aided by Dr. W. W. Cross, United States Vice Consul, and Dr. Ramon de Mazarredo, both of whom gave invaluable assistance, the following facts were obtained.

LOCATION, ETC.

Cienfuegos is built upon a site of which a part projects, peninsula-like, into the harbor. The town occupies about 150 acres, which, about 3 feet above the sea at the water-front, slopes upwards to an elevation of about 75 feet; this being the limit of the houses now built, but not of the summit of the ascent. The whole town is completely commanded by the water-works building, from 100 to 120 feet above the sea. Notwithstanding that the most elevated buildings are some 75 feet above the sea, the majority of the population live on ground 15 feet or less above the sea. More than one-third of the town was formerly a mangrove swamp, and at least one-third of the population dwell where the subsoil water is within 3 to 6 feet of the surface, and where the contents of the privies rise and fall with the tide. About 150 blocks or squares are built upon, some of these containing a number of vacant lots. The blocks are 92 yards square, and a house-lot occupies about 35 by 110 feet. The surface soil varies in thickness; it is comparatively thin; the foundation rocks often crop out on the surface. The rocks are, over a large extent, firm sandstone.

DRAINAGE.

This is, by nature, admirable; none the less, a large portion of the population, possibly one-half, live in ill-drained places. Fronting the harbor many houses could be seen with stagnant pools of water, covered with green slime, in the front or back yards —pools which a few hours work could permanently drain.

STREETS.

These are more than 40 feet wide; the most spacious seen anywhere in Cuba. They are not paved but macadamized. In the central part of the town, they are clean and attractive in appearance.

WATER-SUPPLY.

Although the water-works have a fine building commanding the town, they fail as yet to supply water. About one-third of the population have underground cisterns, and sell water to the other two-thirds.

HOUSES.

There are many mean, wooden frame-houses. As everywhere in Cuba, the floors are directly on the ground, some a few inches above the sidewalks, many on a level therewith, and some even below the level of the streets. The houses occupy more space and are better ventilated than in Havana. The privies here are as foul as everywhere in Cuba. An old American resident, having an admirably clean, well-kept house, stated that his privy had not been cleaned, certainly, for seven years.

HARBOR OR BAY OF JAGUA.

This exquisite harbor of "the first class," affording safe anchorage for the largest vessels, is about 11 miles long by from 3 to 5 miles in width. It is entered from the south by a narrow, deep channel about 3 miles long. Cienfuegos is about 5 miles distant from the harbor-extremity of this channel. Three rivers of considerable size, two to the north and one to the south of Cienfuegos, empty into this large harbor, besides several smaller streams. The harbor is, for the most part, inclosed by beautiful hills, while its southern extremity is adorned by a chain of picturesque mountains of even majestic appearance. Of these Humboldt says: "The hills of San Juan form a limestone chain, very steep on its southern side, and some 1,800 to 2,000 feet high; their naked and arid summits now rounded, and now forming high and steep peaks." He further adds that, though the temperature falls very low here during the season of the northers, yet it never snows; however, frost and hail are sometimes seen in these mountains and in those of Saint Iago.

The anchorage ground is from one-eighth to one-half mile distant from the water front of Cienfuegos. Some twenty wharves extend about 300 feet from the shore into the harbor, and at these is found from 12 to 14 feet depth of water, so that while many vessels are during their whole sojourn moored at these wharves, even steamers of more than 2,000 tons here receive the first part of their cargo, and then the balance thereof, by lighters, at the anchorage ground, which is from one-eight to one-half mile distant from the wharves. The average tonnage of vessels trading at Cienfuegos is from 300 to 500 tons, and their average time at the wharves is from 15 to 20 days. During my stay at Cienfuegos there were not more than ten vessels at anchor, and these were at considerable distance from each other.

BALLAST.

No ballast is kept in Cienfuegos; the few vessels needing it procure it by lighters from the opposite western shore of the harbor.

POPULATION.

The census of 1846 states that the population was 4,324, occupying 63 blocks; that there were 13 cisterns, and that the town was very poorly supplied with potable water.

TABLE No. 55.

Census of—	White.	Asiatics.	Colored.	Males.	Females.	Total.	Number of houses.
1862	6,086	....	3,864	....	....	9,950	1,299
1877	13,444	685	6,189	10,832	9,486	20,318	1,929
Or	13,130	669	6,419	10,852	9,366	20,218	....

N. B.—Two official reports, both from the mayoralty of Cienfuegos, gave the above discrepant figures for 1877.

TABLE No. 56.—*Baptisms or births.*

Year.	White.	Colored.	Total.
1877	596	317	912
1878	539	386	925

N. B.—Of the 9,486 females yielding these births, 5,991 were white and 3,585 were colored.

DEATHS.

TABLE No. 57.—*Mortality statistics from the church register.*

Year.	Whites.	Colored, and said to include Asiatics.	Total.	Remarks.
1857	107	90	197	
1858	229	95	324	
1859	197	130	327	
1860	242	129	371	
1861	383	316	699	
1862	363	256	619	
1863	213	136	349	
1864	298	162	460	
1865	278	200	478	
1866	197	172	369	
1867	261	173	434	
1868	992	381	1,373	Cholera and small-pox, and the insurrection began, forcing many refugees into Cienfuegos.
1869	427	226	653	
1870	480	913	1,393	
1871	621	694	1,315	
1872	628	191	819	
1873	296	203	499	
1874	356	268	624	
1875	602	332	934	
1876	1,374	322	1,696	Yellow fever very severe.
1877	963	476	1,439	Yellow fever and croup.
1878	661	273	934	
First eight months of 1879	314	182	....	

DEATH RATE.

Taking the census of 1862 and of 1877, and the annual average deaths for the three years 1861-'62-'63, and 1876-'77-'78, the average annual death rates would be:

TABLE No. 58.

Years.	White.	Colored.	Total.
1861-'62-'63	52.57	61.07	55.87
1876-'77-'78	75.06	52.00	66.74

A glance at the mortality statistics, Table No. 57, shows that the deaths for the two sets of years cited happen to be exceptionally great; hence the large death-rates somewhat mislead; and further, the excessive death-rate of the whites compared with the colored death-rate of the years 1876-'77-'78 is certainly exceptional, due probably to yellow fever in 1876 and 1877. To correct any misapprehensions in these particulars, the death-rates for 1879, deemed by all in Cienfuegos a remarkably healthy year, have been calculated from the data for the eight months reported; the results are 35.03 for the whites, 39.71 for the colored, and 36.6 for the total population. Thus, the death-rate of a most healthy year in Cienfuegos was very high.

DISEASES.

In addition to yellow fever, small-pox causes in Cienfuegos, as everywhere in Cuba, great mortality, the popular prejudice being very strong against vaccination, so that many hide away from the physicians, who for the public good seek to vaccinate all.

Fully one-half of the sick suffer directly with malaria, which complicates nearly every disease. In 1878, of 3,046 admissions, January to August, in the military hospital, 2,370 had malarial fevers. Dr. Mazarredo, a native of Cienfuegos, stated that cases of diphtheria now occur every year, and that this disease tends to become endemic, although never known until 1858, when freer commercial intercourse was opened with Havana. He further stated that Havana suffered with this disease severely in 1861, and Cienfuegos in 1862.

YELLOW FEVER.

This disease is considered by all in Cienfuegos as an endemic; that is, that its poison is annually and habitually present. This must have been the case from an early

period in the history of the place, since Dr. Mazarredo stated that for forty years there had never been so little yellow fever as in 1878 and 1879. Peñuela, writing in 1854, stated that yellow fever inflicts some damage on the public, but specially afflicts the troops and the men-of-war in the harbor.

Further, the military hospital statistics, Table No. 46, for the 28 years, 1851–1878, show some cases of yellow fever annually, except for the three years 1857, 1862, and 1874. Also, that the disease prevailed particularly, 1851–'55, 1858–'59, 1865, 1867–'71, and 1876–'77. These same statistics again illustrate that there may be few patients in a hospital one year with much yellow fever, and many patients another year without a case of the disease; for instance, in 1856, of 273 patients 27 had yellow fever, while in 1857, of 435 patients, not one had the disease. In the original monthly reports, it is further noteworthy that cases occurred in every month of the years 1868, 1869, 1876, and 1877, and that specially since 1867 cases have occurred in December, January, and February.

Cienfuegos suffered from a violent epidemic in 1876, which was especially severe in the shipping. The disease prevailed again, but to less extent, in 1877. But in 1878 there were but 14 cases in the military hospital, and only one death in the civil hospital. I was officially assured that in 1879 there had been not one case, but a personal inspection proved this statement false, as usual. Two cases were recorded at the civil hospital in January, 1879, and Dr. Mazarredo, after careful inquiry, reported the death of one Spaniard, living near the wharves, in June; another case also occurred but recovered; and, finally, a third case occurred, in a Cuban child, three years old, born in Cienfuegos. Although some physicians diagnose all doubtful cases typhus, none the less the above facts prove that the disease prevailed to remarkably little extent in 1879. In the shipping there were no cases; of 126 American vessels in the harbor, from January to September, 1879, not one had suffered; in fact, on all these vessels there had been only one case of sickness, and this was not due to yellow fever.

The following facts assist in explaining the unusual exemption of Cienfuegos in 1878 and 1879 from yellow fever. In the first place, the severe epidemic of 1876, and its continued prevalence in 1877, left an insusceptible population. In the next place, the garrison consisted of only about 120 soldiers, who were veterans, therefore generally, if not totally, acclimated. Finally, the number of unacclimated young Spaniards seeking employment at Cienfuegos was estimated by Dr. Cross not to exceed 40 annually; there has been, since 1876, very little immigration to any of the southern ports, Cienfuegos, Trinidad, Zaza, or Cuba, in fact to any of this section of country, which was the chief seat of the insurrection of 1868–'78. Hence, on removal of the unacclimated soldiers, yellow fever has had little material to operate upon.

The evidence was very positive at Cienfuegos that in 1869 Cuban refugees from the surrounding country suffered severely with yellow fever.

Little reliable information could be procured about adjacent towns; however, I was assured that Palmira, the only town of any size near to Cienfuegos, had suffered with yellow fever, although this was not usual. Palmira, a low, muddy, ill-drained, and filthy-looking place, is visited by very few strangers; had in 1862 a population of 1,890, now said to be about 1,000, and is on the railroad, about 10 miles north of Cienfuegos. Frost was never known in Cienfuegos, except in December, 1856.

CHAPTER XXXVII.

COBRE.

This town, founded in 1558, is in the province of Cuba or Santiago de Cuba, and is about 7 miles due west of the city of Cuba. It is located on the southern side of Mount Cobre. It is situated in a wild mountain region long celebrated for its numerous copper mines, some of which were worked in 1524. One, owned by an English company, is still in successful operation. Its shipping point is Punta de Sal, on the west side of the harbor of Santiago de Cuba, and about 2 miles from the city, which is on the east side. A ferry connects these two points, and, since 1848, there has been a horse railroad from Punta de Sal to Cobre, about 5 miles distant. The cars are reported to run only three to four times a week.

The census of 1862 stated the population to be 3,571. The mayor reported, through the Spanish Commission, as follows: "The inhabitants number 3,444, of whom 792 are whites and 2,652 colored. In addition, the military population is estimated at 400 to 500, and of these about 100 are unacclimated. There are no other unacclimated persons here.

"Yellow fever has never been known to prevail here. A few soldiers are sometimes attacked in July and August, and occasionally an unacclimated Spaniard. There have never been more than six deaths per annum among the soldiers. There have been no yellow-fever deaths among the citizens, and no residents are known who

have suffered with yellow fever on visiting infected places. In adjacent hamlets the disease is unknown, but occasionally it does occur among soldiers. Frost does not occur here."

Those familiar with yellow-fever literature will recall that Cobre was on one occasion of great interest, in connection with the noted official report of Dr. Buchanan. The English bark Hecla, loaded with copper ore, sailed from the harbor of Cuba July 26, 1865, and arrived at Swansea, Wales, September 9, 1865. The crew suffered with yellow fever on the voyage. Shortly after arrival there were 29 cases and 16 deaths in the town, among apparently only those inhabitants who had been on board of or had had direct communication with the Hecla; and no case was, as it seemed, due to personal contagion. A smack lying for two days close to the Hecla was infected, the disease developing on board after its departure from Swansea. The Hecla was removed from the harbor, and the disease at once disappeared from the town.

CHAPTER XXXVIII.

COLON.

This town, founded in 1818, is in the province of Matanzas. It lies on the railroad, about 30 miles southeast of Cardeñas, and 50 miles northwest of Cienfuegos. In 1862 its population was 1,271.

Through the Spanish Commission, the following statement was made: "Yellow fever does not prevail in Colon in any form. During the war more than 100 soldiers in the hospital here failed to present a single case, which fact makes it evident that yellow fever is not indigenous to Colon."

Drs. Dumont and Elcid (vol. 8, Anales), reporting the yellow fever epidemic at Recreo in 1865, state that an epidemic of yellow fever had occurred at Colon, as asserted by its resident physicians, but denied by the Cuban superior board of health as impossible, because Cubans, in its opinion, were not liable to the disease—a view emphatically and justly rejected by Drs. D. and E., who omit to state in what year this disputed epidemic at Colon occurred, but imply, in 1865, that it had occurred recently.

CHAPTER XXXIX.

CUBA OR SANTIAGO DE CUBA.

Cuba, as this city is commonly called, is in the province of the same name; was founded in 1514, and the famous Hernando Cortez was its first mayor. It is the most southern place of any note in the island, being on the 20th degree of latitude, while Havana, the most northern point of note, is 23° 9′ 26″ north latitude, or a distance, on a parallel of longitude, of about 200 miles; however, Havana lies so far to the west that the real distance between these places is about 600 miles.

The surrounding country is very mountainous, and this city is built upon a steep slope; the public square, or Campo de Marte, is 140 to 160 feet above the sea, and some of the houses are located 200 feet high. The character of the soil is reported to be more volcanic than calcareous; it suffered by earthquake in 1608, 1675, 1682, 1766, 1826, and in 1776 a large part of the town was thereby destroyed. It is frequently disturbed by "shakes"; once in 1870.

Cuba has no railroad communications, but is connected by steamship lines with other Cuban ports. It is the second city in the island in the number of its population, slightly exceeding Puerto Principe and Matanzas. However, so far as American commerce is concerned, it ranks only ninth among the 15 Cuban ports of entry. Its total maritime intercourse is indicated by the following figures:

TABLE No. 59.

Years.	Total number of vessels.	Spanish vessels.	Foreign vessels.	Total number of crews.	Spanish crews.	Foreign crews.
1877	377	217	160	9,620	5,790	3,830
1878	439	225	214	11,139	6,121	5,018

It is located on the extreme northeastern bank of the harbor of Santiago de Cuba, a harbor of the "first class," and one of the smallest; hence, as is believed, the great liability of its shipping to infection. According to the chart of the Madrid hydrographic bureau, 1863, this harbor is from its sea entrance to its extreme northern limit 5 miles long, the city being located 4 miles from this entrance on the northeastern side of the harbor. The entrance is, for some little distance, very narrow, not more than 220 yards wide, and may be considered about 2 miles long, with a width varying from one-eighth to five-eighths of a mile. For the remaining 3 miles, the harbor gradually widens, until at its northern extremity it is about 2 miles wide. However, the city is so situated in a cove of the harbor that the opposite shore is only about one-half mile distant. At the wharves, from 10 to 16 feet of water is found, and within 300 to 500 yards of the shore, from 20 to 30 feet. This, therefore, is probably the anchorage ground. Three or more so-called rivers, besides other streams, empty into this harbor, and one of these, the Caney River, empties directly at the northern limit of the city, so that its water flows from one inland extremity through the whole harbor into the sea. The difference here, as elsewhere in Cuba, between low and high tide is about 2 feet.

Three official reports were received from Cuba, one from Mr. John C. Landreau, United States consul, and two others through the Spanish Commission, one of them from Mr. J. Cañizares, secretary of the mayoralty, and the other from the municipal board of health, signed by its secretary, Dr. A. R. Campiña. From the last valuable report, the following facts have been obtained, except where otherwise stated:

TABLE No. 60.—*Population.*

Census of—	Whites	Asiatics.	Colored.	Total.	Number of houses.
1862	13,377	....	23,124	36,491	4,170
1877	19,792	121	20,922	40,835	5,100

TABLE No. 61.—*Annual deaths.*

	Civilians.	Soldiers.	Total.
1877	1,406	1,520	2,926
1878	1,412	1,703	3,115

The death rate for the civil population for each year was 34.5.

YELLOW FEVER.

This is one of the most noted yellow-fever centers in the island; the disease has prevailed annually certainly since 1851, and probably very many years prior to this. The board of health reported: "Some assert that yellow fever first appeared here in 1686, imported from Martinique, but the most reliable data state that the disease was not known until 1745–1748." Peñuela, writing in 1854, mentions yellow fever as one of the diseases which habitually prevails. The military hospital statistics are for the 28 years 1851–1878, and as will be seen by reference to Table No. 46, there were cases of this disease every year without exception, the number ranging from 5 to 838. These statistics again illustrate the independence of the disease, during certain years, of aggregations of men; for instance, in 1874 there were 9,921 admissions by all diseases, yet only 47 cases of yellow fever, while in 1869, with only 6,418 admissions, there were 539 cases of this disease.

The board of health reported: "Yellow fever is endemic in this place, varying in annual intensity with the season, and especially with the number of the unacclimated." (Dr. P. Selsis, now of Havana, but formerly of Cuba, estimated the number of unacclimated annually arriving at 100, exclusive of the crews of vessels.) "One and nearly two years have elapsed without a single case except in the hospitals. Prior to 1868 there were few unacclimated here, and yellow fever had little severity, but this has much increased since 1868, on account of the large number of the unacclimated brought here by the war. It prevails with greatest intensity in the harbor, the barracks, and the hospitals, spreading in these places by infection. It attacks especially strangers, the natives rarely, and negroes never. Native-born Cubans, who remain permanently in the city, are exempt from yellow fever, but children born here,

and early taken to the adjacent mountains or to northern countries, and returning here when adults, have been attacked with the same intensity as if strangers. Cases have frequently occurred in soldiers who have lived seven to eight years in the inland towns of the island. Formerly yellow fever was unknown in the adjacent rural towns, and even in settlements on the limits of this city, but during the war the disease was known to prevail in the military hospitals established in camps more than 1,000 feet above the sea, prevailing therein epidemically and by infection. In these instances, the disease was undoubtedly imported, either by clothing or persons; for it is well known that these hospitals were provided with their necessary supplies by the central hospital located in this city, and that communication between said rural hospitals and this city and harbor was constant. The rural camps were occupied by raw, fresh recruits recently arrived from Spain. This city with its 40,000 population is very badly sewered; all its refuse, together with that of the vessels, is poured into the harbor. Our annual average temperature during the five years 1874–78 was 26° C. (78.8° F.)."

Mr. Landreau reported that, as a result of the insanitary conditions of the city, yellow fever might be considered indigenous; that cases of yellow fever have often been reported in Spaniards coming to this port at a time when there had not been reported a case within a period of more than two or three months, and these have died though subjected to the best hygienic conditions; that, excluding soldiers, the number of immigrants, therefore, of the unacclimated, has been very small during the past ten years; that, while creole negroes are not liable, it is doubtful whether natives are; and that while inland towns are less exposed to yellow fever than sea-ports, yet, "during the war all the towns of this department were garrisoned by Spanish troops, and they were decimated by yellow fever."

Mr. J. Canizares reported the monthly deaths by yellow fever in 1877 and 1878 as follows:

TABLE No. 62.

Month.	1877.		1878.		Month.	1877.		1878.	
	Citizens.	Soldiers.	Citizens.	Soldiers.		Citizens.	Soldiers.	Citizens.	Soldiers.
January	6	29	1	45	August	5	86	5	146
February	0	11	1	25	September	12	136	1	75
March	2	5	2	12	October	27	78	1	33
April	2	0	1	32	November	25	75	3	12
May	2	4	2	7	December	12	82	0	1
June	1	6	0	60					
July	4	12	4	63	Totals	98	519	21	531

The monthly statistics of the military hospitals, 1851–1878, prove, as a general rule, the presence of cases of yellow fever at Cuba every month of every year.

An unpleasant fact respecting Santiago de Cuba deserves record. Two of the official reports from this place united in calling attention to the refusal of the ecclesiastical authorities to furnish the annual deaths from the church register, unless well paid therefor—this, in spite of the order of the governor-general of Cuba that all authorities in Cuba should freely aid the yellow-fever commissions in the discharge of their duty. In Cardeñas and Cienfuegos I personally encountered difficulty in securing from the churches the records of annual deaths. From no other persons in Cuba, except from these ecclesiastics, was any conduct encountered other than great courtesy, with appreciation of and hearty willingness to aid the humane and scientific objects of the commission.

CHAPTER XL.

GIBARA, OR JIBARA.

This modern town is in the province of Cuba, and is the sea-port of the important inland town Holguin, about 16 miles to the south, and connected therewith by a royal high road. The surrounding country is mountainous, but Gibara is only 18 feet above sea-level. Gibara is a port of entry, however, of so little consequence that it is not visited by more than 5 to 10 American vessels annually. It is located on the west bank and near to the broad entrance of the harbor of Gibara. Pezuela states that,

"as a general rule, the usual depth of this harbor does not exceed two fathoms, and, therefore, only coasting schooners can enter it." Hazard states, "The bay is very beautiful and capacious, though not deep enough to permit vessels to come up to the wharves; so they are compelled to anchor some distance off, and be loaded by means of lighters." Pezuela also states that this town is healthy, except during the rainy season, when malarial fevers prevail. Steamships halt at Gibara at least three times a month, connecting this with other Cuban ports.

POPULATION.

The census of 1862 states the population as 1,610, viz: 1,082 whites and 528 colored, living in 225 houses. In 1877, the population was 4,960, viz: 3,586 whites, 24 Asiatics, and 1,350 colored, living in 503 houses.

DEATHS.

Through the Spanish Commission a report was received from Dr. Lucas Gallerdo, secretary of the municipality of Gibara, and to this report the following facts are due: The number of deaths annually among the inhabitants vary from 150 to 200; and this yields a death-rate of from 32.25 to 40.32.

YELLOW FEVER.

Dr. Gallerdo reported: "I regard yellow fever as indigenous to this place. Prior to my arrival here in 1872, I have only vague information as to the disease, but it prevailed here in the summer of 1872, in the spring of 1873, and in 1876. Exclusive of soldiers and sailors, the unacclimated number probably about 200. I can assure you that I have attended numerous cases of yellow fever in residents of this town, who had never left it. Among these were some cases of children four years old and upwards. Every summer I have attended cases of yellow fever in natives of the country, who had never left their places of residence, and this especially in the level southern part of this municipal district, as in the villages of Fray Benito, Potrevillo, Junicu, and Bariay. I have hearsay knowledge of natives of the interior having been attacked with yellow fever on visiting villages on the coast."

Peñuela, writing in 1854, fails to enumerate yellow fever among the prevalent diseases at Gibara, and states positively that it does not occur in the jurisdiction of Holguin, in which Gibara is located.

The military hospital statistics, Table No. 46, cover the 21 years, 1858–1878. During seven of these years there was not one case of yellow fever, and during six other years only from one to fourteen cases. The years of exemption and of greatest prevalence corresponded closely with like years at Holguin. It is noteworthy thatin 1874, there were only 6 cases of yellow fever in 2,693 patients admitted, while in 1863 there were 14 cases in only 66 admissions.

CHAPTER XLI.

GUANABACOA.

The steeples of this town are in sight of Havana; for this reason, and because of numerous and positive reports from intelligent sources, that it was exempt from yellow fever, never having any cases except those who became infected by visiting Havana, Guanabacoa was personally inspected, and much time given to discover the facts.

This town, in the province of Havana, was founded, says Pezuela, in 1555. Hazard writes, "Guanabacoa was originally a village of Indians. In 1554, all the wandering natives were collected from its neighborhood, and organized into a village, which, in 1743, was thought worthy of being called a town."

It is 3 miles due south of the north coast, but only 1¼ miles distant from the nearest part of the harbor of Havana. It is 4.8 kilometers, or 3 miles, by rail from Regla, with which it is connected by railroad trains every half hour. Ferry-boats traverse the three-fifths of a mile across the harbor, from Regla to Havana, every few minutes. Many officers, clerks, &c., who work daily in Havana, live and sleep in Guanabacoa. The altitude of its public square is 45 meters, or 148.6 feet; built on the summit and sides of this commanding hill, the town varies in altitude from 130 to 160 feet.

Owing to its altitude Guanabacoa enjoys two great advantages: it is well swept by the winds, and its natural drainage is excellent. The sea-breeze by day comes from

the east, the land breeze by night from the southeast, so that very rarely indeed do winds prevail from the west, *i. e.*, from the direction of Havana. Notwithstanding the excellence of its natural drainage, this town is by no means a clean one. Its streets have neither pavements nor sidewalks. Scraps of dirty paper, old cocoa-nut hulls, loose, rough stones, disorder, and filth characterize the streets. The houses are, in considerable proportion, small, crowded together, ill ventilated, and, in appearance, most uninviting. The privy system is the same filthy, nauseating, and most objectionable one which characterizes Cuba; they are emptied, by buckets, into barrels at the front door, and this but seldom, never until filled to the brim. An old resident physician farther reported that sometimes the kitchen and other household refuse is, before removal, accumulated for months in a corner of the kitchen. The same authority, Dr. A. W. Reyes, a graduate of Paris, an editor of the Gaceta Medica of Havana, an accomplished schôlar, and a most valued friend to the American Commission, farther reported, "we live by a miracle, and the climate is held responsible for what is the result solely of ignorance, laziness, and the lack of proper cleanliness and care. Our stables are so located as to propagate glanders; and all things concerning our insanitary conditions being duly considered, it is surprising we get along as well as we do, rather than that we are so sickly." Guanabacoa is noted for its numerous springs and wells, and for the excellence and abundance of the drinking water. Its geology is peculiar, and since much has been said of this in connection with yellow fever at Guanabacoa, Dr. Reyes was kind enough to procure the following notes from a distinguished geologist and mineralogist, the Rev. Francisco Clerch, of the College located at Guanabacoa of the Escolapian Fathers: "The soil here differs entirely from that of Havana and of Jesus del Monte, which is of limestone or coral. Two geological formations characterize Guanabacoa, a volcanic and a sedimentary formation, both tertiary, and likened by Humboldt to the Jura formation. The volcanic formation is of serpentine, which begins near the Marimelena cove of the harbor of Havana. On both sides of the serpentine zone, running in the same eastern direction, are zones of silicious marl, which, in many places, is very compact, and excellent for building purposes. The serpentine formation is evidently posterior to the marl and limestone formations. In the lines of direction between the serpentine and the two marl zones, quartz extraordinarily abounds in all its varieties. The presence of very compact primitive limestone is also remarkable. The petrosilex also requires attention; it is a feldspar-like mass of varied colors, containing exceedingly small crystals of feldspartine, which may be classified as genuine porphyry. Guanabacoa is situated in the center of the serpentine zone. The waters of its excellent and abundant springs and wells contain an abundance of magnesian salts with salts of lime and iron; in some springs the water contains an organic aromatic substance, evidently asphaltum, which abounds throughout the serpentine zone."

Because of its elevation, the temperature of Guanabacoa is lower than that of Havana. Dr. Reyes states that the general annual range of the thermometer is from 22° C. (71.6° F.) to 30° C. (86° F.), and that the maximum is 32° C. or 89.2° F.

TABLE No. 63.—*Population.*

Census of—	White.	Colored.	Total.	Number of houses.
1862	8, 817	7, 585	16, 402	2, 918
1877	13, 890	6, 611	20, 501	....

TABLE No. 64.—*Mortality statistics of Guanabacoa for the six years,* 1874–'79, *reported by Dr. A. G. Del Valle.*

Diseases	Total deaths for the years—					
	1874.	1875.	1876.	1877.	1878.	1879.
Alcoholismus	....	1	1	2	1	3
Anthrax	1	....	....	....	....	....
Beriberi	1	....	....	....	....	....
Cerebral congestion, apoplexy	27	22	28	27	9	15
Cholera infantum	44	25	48	43	52	53
Diarrhœa	44	41	37	43	20	40
Dysentery	9	7	6	4	11	13
Diphtheria	7	6	6	15	11	14
Eclampsia	7	7	2	10	15	7
Erysipelas	1	....	3	....	....	....

TABLE No. 64.—*Mortality statistics of Guanabacoa, &c.*—Continued.

Diseases.	Total deaths for the years—					
	1874.	1875.	1876.	1877.	1878.	1879.
Fevers:						
Bilious	8	7	5	2	3	3
Paludean	47	36	36	24	18	24
Typhoid	21	13	11	10	12	10
Yellow	13	7	12	14	6	7
Heart disease	40	30	51	48	41	52
Hepatic disease	30	32	36	28	32	33
Hooping cough	1	....	....	1	5	....
Hydrophobia	1	....	....	....	....	....
Measles	6	1	....	2	....	....
Meningitis	48	42	47	45	57	40
Pemphigus	....	....	....	2	....	2
Phthisis	204	177	206	160	215	247
Pneumonia	39	32	42	31	37	51
Scarlatina	....	1	....	1	....	....
Small-pox	20	67	5	56	90	68
Tetanus	6	9	12	13	8	6
Tetanus, infant	46	46	61	63	57	60
All other diseases	127	117	135	118	191	172
Totals	804	726	790	762	891	929
DEATHS BY RACES.						
Whites	473	431	487	457	575	533
Colored	331	295	303	305	316	396

Preceding reports yield as the death-rates for the annual averages of the six years, 1874-'9—whites, 35.5; colored 49.0; total population, 39.8—results in striking contrast with the popular belief that Guanabacoa is not only free from yellow fever, but also a remarkably healthy place. The great prevalence of phthisis, small pox, infantile tetanus, and probably also of malarial fever, with the little prevalence of measles, scarlatina, and diphtheria, illustrate facts common in Cuba.

YELLOW FEVER.

Peñuela enumerates yellow fever among the prevailing diseases in the jurisdiction of Guanabacoa, and especially refers to its prevalence in 1853, 1854, the only years the statistics of which are recorded by him.

The military hospital statistics, Table No. 46, embrace only the 15 years, 1852–1866, the period during which a military hospital was in operation. Of 2,481 soldiers admitted during this time, 88 were cases of yellow fever. During five of the 15 years there were no cases, during six other years there were from 1 to 9 cases only, and during only 3 years were the cases at all numerous. This little prevalence may, very probably, have been due to the garrison having been composed of a small detachment of acclimated soldiers from Havana. The municipal board of health, reporting through the Spanish Commission in 1879, stated that yellow fever does prevail but only to slight extent, and added "we know of no towns in the immediate neighborhood of Guanabacoa which are exempt from yellow fever."

Dr. A. G. Del Valle's annual statistics, above published, prove an annual average during the six last years of 10 yellow-fever deaths, as certified by the physicians of the place. How many more died of the same disease, but undiagnosed, and certified to be of some other disease, is conjectural, but no one who has lived in a community prejudiced against a belief in the presence of yellow fever will deem it at all improbable that many more did die of yellow fever than shown by the certificates of death. It is also important to remember that even ten deaths annually imply from 30 to even 100 cases; hence the annual acclimation of a considerable number.

These facts suffice to prove that cases and deaths of yellow fever have long occurred, and do still occur annually, in Guanabacoa, but when it is considered that Guanabacoa has over 20,000 population, and that it is less than 4 miles from Havana, with which it has half-hourly communication by rail, it must be conceded that the comparatively small number of cases might be readily accounted for by infection in Havana. It became my duty to solve whether such an inference in accord with the common rumor was true or false, whether persons living in Guanabacoa who had not visited Havana or other infected place, were or were not ever attacked with yellow fever. Fortu-

nately encountering Dr. Reyes, he secured the intelligent and willing aid of his friend, Father Clerch, and the following decisive facts were contributed by these gentlemen:

Father Clerch reported that 22 years ago cases of yellow fever were very rare in Guanabacoa, and occurred only in August and September, but that with increase of population, increase of intercourse with Havana, and especially since connection therewith by rail in 1858, the number of cases have increased, and that these are now observed both prior and subsequent to said months. Cases occur in persons who, though in constant contact with acclimated persons daily visiting Havana, have none the less themselves not visited Havana. In proof of this the following facts were cited in respect to the 70 priests and brothers of the Escolapian College, who have dwelt therein from December, 1857, when the college was founded to September, 1879. During these 27 years this population of 70 had eight indisputable cases of yellow fever, and three other cases which were questioned. Four of the eight indisputable cases died, and so did all those of the questioned cases. Thus out of eleven probable cases seven died. Such a rate of mortality points clearly to a much larger number of cases, who, no doubt, did suffer with mild but acclimating attacks. This supposition is strengthened by the following details as to the eleven cases:

In 1858, there were four well-marked cases of yellow fever, all recovering, in persons who had taken the best hygienic precautions, and had abstained from visiting Havana since March. Among these four was Father Clerch himself.

From 1858 to 1865 there were no well-defined cases of yellow fever, but cases of fever did occur in which the symptoms disappeared on the fourth day, the patients taking nourishment on the fifth.

On August 27, 1865, Father José Plans died of yellow fever. While suffering with intermittent fever he was suddenly seized with well-marked symptoms of yellow fever. He had lived three years in the college, had hardly ever left it, and it is not remembered that he had ever visited Havana.

On September 5, 1865, Father M. Guineno died, of what is believed to have been yellow fever. He had resided in the college since November, 1858, hardly ever left it, and it is believed that he had not gone to Havana.

On September 10, 1867, Father J. M. Hernandez died of yellow fever. He had lived two years in the convent and had abstained from going to Havana.

On July 28, 1873, Father J. Salas died of yellow fever. He had visited Havana and preached at Jesus del Monte five days before his death.

On September 28, 1873, Brother M. Garcia died of what is believed to have been yellow fever. He had not visited Havana for two years.

On November 29, 1875, Father J. Samoga died with all the symptoms of yellow fever. During his two years of residence in the college he had traversed Havana only once en route on a visit to the country.

On May 2, 1878, Father J. Ponce died, on the fifth day of a so-called "malignant fever," which Father Clerch firmly believes was yellow fever.

Such are the significant details selected from the histories of these eleven cases in a population of only 70 unacclimated persons, and it is very notable that of the seven total reported cases which occurred since 1865, every one of them died. This is so highly improbable, that it would be easier to credit that all of the 70 persons had been attacked and only seven died, than to credit that seven died out of only seven cases. The probability that there were many more than seven cases is increased by three considerations: First, by the fact reported by Dr. Reyes as to Guanabacoa, and repeatedly noted by me in Cuba, that many physicians refuse to diagnose a case of yellow fever, unless, in addition to other well-marked symptoms, there be albuminaria; this is as unjustifiable as it would be to refuse to diagnose variola unless the pustules become confluent. Second, because of the excellent sanitary condition of the convent and of its inmates, the chances for recovery were excellent. In respect to the favorable sanitary conditions, the following facts are reported: The location of the college is excellent; well-water of superior quality kept in large admirable cisterns is alone used; extreme cleanliness of linen and of everything is observed, so that no stagnant water, or decomposing matter of any nature are ever to be found; every two years at least visits are paid in August to the country; exposure to night and to damp air is avoided; visits to Havana, from March to October, are abstained from by the unacclimated; and the greatest care is used as to diet, which is always of fresh, wholesome food, while all stimulants are used in great moderation. Third, because Father Clerch reported "There have been some cases of yellow fever which were not well defined," and "There have been some cases of bilious fever cured after three to four days of sickness."

Whatever conclusion may be reached as to the probable number of cases, no doubt can be left that yellow fever has been repeatedly contracted in Guanabacoa itself, and that the facts, proved in respect to only seventy highly educated unacclimated men, placed under unusually good hygienic conditions, must be illustrative of what the facts, probably even more unfavorable, really are in respect to all of the unacclimated residents of Guanabacoa. The ignorant and the interested may succeed in denying and concealing the truth, but honest seekers for this will find it in the preceding facts.

Excluding the eleven cases occurring among the 70 priests and brothers, two other cases of yellow fever occurred in the college of interest. One case was of a priest, who, after six years' residence at Puerto Principe, was attacked in 1863, when on a visit to Guanabacoa; a second and fatal case occurred in a native of the province of Pinar del Rio, whose disease was not admitted by his attendants to be yellow fever until his death, because he was a Cuban.

It deserves special notice that Father Clerch also reported, in respect to the 70 priests and brothers of the college, that some of them have lived in the college eight successive years without experiencing any symptoms of yellow fever; that two have remained eighteen years and have had only a slight fever, and that one resided here eighteen consecutive years, and another twenty-one, without any sickness.

In conclusion, it will be observed in the mortality statistics that in 1879 there were only seven reported deaths by yellow fever in Guanabacoa. The following facts serve to explain this small mortality in a population of 20,000. Drs. Reyes and Del Valle, both residents of Guanabacoa, striving to estimate approximatively the number of the unacclimated population, concluded that "the number of the unacclimated residing, since the last two years, at Guanabacoa is about 200." Drs. Reyes farther reported, as to 1879, that he alone had heard of twelve cases, four of whom had not been out of Guanabacoa for at least three months; and of these cases he reported the facts in detail. He estimated the total number of cases in Guanabacoa at not less than 25 to 30 annually, and he concluded, in opposition to public rumor, that, "as a matter of fact, yellow fever does prevail severely at Guanabacoa, so that the special nature of the soil, and the superior quality of the waters are of secondary consequence in the causation of yellow fever."

Public rumor, indorsed by highly intelligent citizens and by some physicians, assign to Marianao the same exemption from yellow fever claimed for Guanabacoa; but reference to the special report for Marianao, Chapter LI, will show the existence of a like series of facts. These should serve as a serious lesson to two classes of yellow-fever partisans; first, to those who cite such instances as Guanabacoa and Marianao in proof that yellow fever cannot be imported; second, to those who give ready credence to the assertions of residents in yellow-fever localities that these are always, or at some specified time, absolutely free from the disease. Nothing less than a most careful inspection by a disinterested and experienced medical inspector deserves any confidence.

CHAPTER XLII.

GUANAJAY.

This inland town is in the province of Pinar del Rio, about 7 miles south of Mariel, on the north coast, and some 25 miles southwest of Havana, with which it is connected by railroad. Pezeula stated in 1863 that notwithstanding the humidity of its soil, its physical advantages are such that it is one of the best points in the island for the acclimation and convalescence of Spanish soldiers; while in 1879, Surgeon Pardiñas, Medical Director Military Hospitals in Havana, assured me that all of many hospitals established to acclimatize troops had been abandoned for this purpose, because of manifest failures.

In 1862 the population was 3,986, and was reported to be in 1877, 5,505.

No special information was procured as to this place, except such as is elsewhere reported in the statistical tables of Pezuela and of the military hospitals, Tables Nos. 46 and 47.

Pezuela's table indicates a considerable prevalence of yellow fever, 1855–'59, in both the civil and the military hospitals.

The military hospital statistics cover the eighteen years, 1852–1869. During five of these years there were no cases of yellow fever; during seven other years there were only from one to nineteen cases; and during no year was the disease apparently very severe. During the two years, 1864, 1865, there were 2,105 admissions, and only 6 cases of yellow fever; while in 1867, 1868, there were 94 cases in only 1,215 admissions. The maximum number of cases in any one year was 75, in 1857; of these, 55 occurred in November. In some years cases also occurred in December and January.

CHAPTER XLIII.

GUANTANAMO, OR SANTA CATALINA DE GUANTANAMO.

This town, founded, says Pezuela, in 1843, is in the province of Cuba, and about 40 miles northeast of the city of Cuba. Although designated a port of entry, it is, in

fact, about 7 miles from the sea; that is, north of the harbor or bay of Guantanamo. The real sea-port is the village of Caimanera, located on the west bank of the bay of Guantanamo, and connected with the town of Guantanamo by a railroad, which runs 17 kilometers or 10½ miles to the north. Guantanamo is situated on a plain 115 feet above the sea, and on the west bank of the Guaso River. It is encircled by small streams, which throughout the year form stagnant pools, and cause the prevalence of malarial fevers. To the west are hills, and at from 10 to 15 miles distant there are high mountains in every direction, except to the south, the land being for the most part low towards Caimanera.

The harbor is reported to be a very beautiful sheet of water, encircled for the most part by hills, but having portions of the shore low and marshy. From the south a somewhat narrow entrance, some 6 miles long, leads into the harbor, which is irregular in shape, but about 7 miles in diameter. Pezuela reports that the harbor is very deep, "permitting even the largest vessels to enter safely within close proximity to the shore."

Guantanamo, as a port of entry for the United States, ranks only eleventh in importance among the 14 Cuban ports, and is visited annually by about 30 American vessels, presumably in the coffee trade, since the jurisdiction of Guantanamo is now the chief coffee-raising section of Cuba. Reports from this place were received, one from Mr. W. F. Alison, United States consular agent, and two through the Spanish commission, one of these from the board of health, and one from Dr. Joaquin Boote. From these reports some of the preceding and following facts have been obtained.

TABLE No. 65.—*Population.*

Years.	White.	Colored.	Total.
1862	529	1,206	1,735
1877	3,571	4,815	8,386

TABLE No. 66.—*Deaths of citizens.*

Years.	White.	Colored.	Total.
1877	184	341	525
1878	196	335	531
Annual average death-rates for the two years	53.2	70.2	63.

In addition to the above deaths among citizens, 276 soldiers died in 1877, and 280 in 1878.

YELLOW FEVER.

Surgeon Romay, writing in 1797, said, "Vernon's English squadron arrived, infected with yellow fever, in the bay of Guantanamo in 1741"; but since there was not then any town of Guantanamo, or apparently other town on this bay, the above record concerns the English fleet, and does not indicate any infection on land.

The military hospital statistics, Table No. 46, go back to 1851, and embrace 25 years, viz, 1851-'62 and 1866-'78. During 7 of these 25 years there were no cases of yellow fever; during 9 other years there were only from one to ten cases, and only in 1872, 1877, 1878 were the cases at all numerous. In 1867, with only 329 admissions, there were 47 cases of yellow fever, while in 1875 there was only one case, although 3,132 sick soldiers were admitted in hospital.

Pezuela's statistics indicate that in 1855-'59 there were annually admitted into the civil hospital an average of 47 cases of yellow fever.

The board of health reported the following annual deaths by yellow fever:

TABLE No. 67.

	Citizens.	Sailors.	Soldiers.
1874	1	1	2
1875	0	0	1
1876	1	3	11
1877	12	2	110
1878	8	2	153

During the 8 months, January to August, 1879, twenty-one soldiers died of yellow fever.

The board of health reported "On an average, there are not more than 6 to 8 unacclimated civilians in this place annually; the number of unacclimated soldiers varies greatly; at present there are 46 of these. Cases of yellow fever occur every year, and at all seasons, but chiefly from May to October. It prevailed with special severity in 1877, 1878, owing to the increased number of the unacclimated. Yellow fever is believed to be indigenous not only to Guantanamo, but also to the country some 5 miles around it; for soldiers detached on duty in the adjacent country have been attacked with yellow fever. Natives from the mountains are attacked with yellow fever on visiting Guantanamo; two such cases occurred in 1878. Europeans, who lived for several years on coffee estates in these mountains, have also been attacked on visiting this place. The village of Tiguabos, located high in the mountains, 15 miles northwest of Guantanamo, is free from yellow fever, and this is believed to be due, not to absence of the unacclimated, but to the absence of the poison of yellow fever. Frost has never occurred'.' It probably did occur in December, 1856, as it occurred elsewhere in the Island.

Mr. Alison reported: "The mountainous part of the country north of this town is entirely free from yellow fever, owing to its cold climate. Guantanamo is in the healthiest part of Cuba, owing to its elevation; but shipmasters from abroad find that their crews generally suffer here with sickness from May to September. Yellow fever is generally brought here by the shipping from the city of Cuba."

CHAPTER XLIV.

GÜINES.

This town, founded in 1735, is in the provinces of Havana, located on the river Mayabeque, 31 miles by wagon-road, and 71.6 kilometers, or 44 miles by railroad southeast of Havana.

The population in 1862 was 10,619, viz, 6,820 whites and 3,799 colored, living in 1,150 houses. A report from a resident states that in 1877 the population was from 15,000 to 17,000; however, a published report cites the figures as 14,635.

Through the Spanish commission a report was received from the local board of health, which states that the annual deaths of citizens are from 300 to 340; but that during the last six months, March to August, 1879, there have been 300 deaths, there having been an epidemic of small-pox.

YELLOW FEVER.

Pezuela's statistics for the five years 1855–1859, Table No. 47, give an annual average of 43 cases admitted into the civil hospital. The military hospital statistics, Table No. 46, embrace the 14 years, 1855–1868. During 6 of these 14 years there were no cases of yellow fever; only in 1855 and 1858 were the cases at all numerous.

The board of health reported: "Yellow fever was unknown here until 1834, when the railroad was built, thus facilitating commerce with both Havana and Matanzas. [This date is probably erroneous, as a published report states that the railroad from Havana to Güines was opened to travel in 1843, and from Güines to Matanzas in 1861.] Yellow fever is not indigenous to Güines, but imported. Whenever troops have been sent here yellow fever has prevailed, especially June to September, when the air is loaded with vapor, and the thermometer is above 22° C, or 71.6° F. Yellow fever does not habitually prevail here; in some years there is not a case. No case is known of a native having been infected on visiting an infected place. The deaths of civilians by yellow fever are 3 to 5 annually; the number of the unacclimated population is very small, and these are Spaniards. There have been in 1879, to September 6, 10 cases and 5 deaths of citizens. Soldiers who sicken here are now taken to Havana; therefore none die here. Negroes, though much exposed, never die here of yellow fever. Guara, a neighboring village, has very little yellow fever; however, it has infrequent communication with Havana, and few unacclimated residents. Frost has never occurred but once." This was probably, as elsewhere in Cuba, December 24 and 25, 1856.

CHAPTER XLV.

HAVANA.

The official title, "Havana Yellow Fever Commission," and the official instructions *to it*, sufficiently indicate that the chief duty expected was a thorough investigation

of this city. Hence the record of the facts concerning it have constituted the earlier and chief portion of this report. It is therefore unnecessary in this place, the mere alphabetical position of Havana, to record more than references to the facts already reported. These will be found in the following thirteen chapters, viz, Chapters I-V, XV, XVI-XIX, XXII-XXIV, and in the following thirty-four of the total ninety-six tables of this report, viz, Tables Nos. 1, 3, 4, 7-11, 18-40, 45-7.

CHAPTER XLVI.

HOLGUIN.

This inland town, founded about 1720, is in the province of Cuba, and about 16 miles south of Gibara, its sea-port. Pezuela states that it is "situated upon a plain of considerable elevation, and is possessed of the best physical conditions." In 1862 the population was 4,954. It is a point of great military importance, and was occupied by a numerous garrison, 1868-1878.

Peñuela states that the tradition of Holguin records no epidemics of any kind until 1851, when yellow fever and cholera were both imported by troops, and ravaged not only the troops, but also the natives of every sex, age, and condition.

The military hospital statistics, Table No. 46, embrace the 28 years, 1851-1878. During nine of these years there were no cases of yellow fever; during seven other years the number of cases never exceeded 31, and the years of special prevalence were 1861, 1857, 1859, 1870-'77. It is noteworthy that Holguin did occasionally escape when Gibara, its sea-port, did not; but whenever Gibara escaped, so also did Holguin.

CHAPTER XLVII.

ISLE OF PINES.

This island appertains to the province of Havana. It is about 90 miles from the city, and 54 from Batabano, whence a steamer runs once or twice a week. It contains about 540 square miles, a mountain range with a peak 1,650 feet high, and "the most wonderful mineral springs in the world," as is alleged. It has two villages on the north coast, which contained in 1862 a population of 1,293 out of a total population on the island of 2,062. The population of the island in 1877 is reported to have been 1,693.

Peñuela reported in 1854 that "cases of yellow fever, of small-pox, and of cholera have not been seen at the Isle of Pines."

The military hospital statistics, Table No. 46, embrace the 28 years, 1851-1878, and show a remarkable freedom from yellow fever. There were no cases until 1855, and then only two cases; only in 1856, 1859, and 1864 were the cases at all numerous; and during the recent 13 years, 1866-1878, there had not been one case. The records of the military hospitals of Cuba show no exemption comparable to this at any other place except at Bahia Honda.

Having applied to Dr. Pardiñas, medical director of military hospitals in Havana, for an explanation of this unusual exemption, he replied, "Formerly the Isle of Pines was considered a place of acclimation for Europeans, but as many of these who went there for this purpose were attacked, this belief fell to the ground. Owing to the sparse population, the commerce is very small, and the communication with Cuba infrequent. The population is, for the most part, composed of natives. The soldiers are scattered through the country on detached service, and the garrison of about 100 men is taken from the 'white militia battalion of Havana,' which is composed of Cubans. There are 18 to 20 civil guards, who are Spaniards, long resident in Cuba, and therefore probably acclimated."

The above explanation, while valuable, is not entirely satisfactory, for the military hospital statistics report that for the four years, 1875-'78, there were from 542 to 837 annual admissions—numbers too large to reconcile with a military population of only 100 soldiers, and 20 civil guardsmen; numbers so large as to justify the suspicion that there most probably were some unacclimated soldiers among them.

CHAPTER XLVIII.

JARUCO.

This town, founded about 1770, is in the province of Havana. It is about 8 miles south of the north coast, and on the railroad from Havana to Matanzas, 38.5 kilometers, or 24 miles, east of Regla, and 48.5 kilometers, or 30 miles, west of Matanzas. The population in 1862 was 1,599.

The military hospital statistics, Table No. 46, embrace only the five years, 1851–'53 and 1860–'61. During these five years there were only 350 admissions by all diseases, and of these only two cases of yellow fever.

Pezuela's statistics for the five years, 1855–'59, Table No. 47, show no cases of yellow fever in the civil hospital, but an average of 8 cases annually among the soldiers.

By reference to San José de las Lajas, Chapter LXVII, it will be seen that Dr. Esteban de Navea practiced at Jaruco fifteen years, and testified that native Cuban adults and children suffer at Jaruco, as at San José, with a so-called "bilious remittent fever," which he regards as essentially yellow fever.

CHAPTER XLIX.

JIGUANI, OR GIGUANI.

This town, founded in 1737, is in the province of Cuba. It is about 40 miles from the sea-coast. Its sea-port is Manzanillo, from which a high-road runs via Bayamo and Jiguani to the city of Cuba. In 1862 the population was 1,347; whites, 735; colored, 612; number of houses, 186.

Pezuela's statistics for the five years 1855–'59, Table No. 47, show no cases of yellow fever in either the civil or military hospital. The military hospital statistics, Table No. 46, embrace only the eight years of the insurrection, 1871–'78. There were cases of yellow fever every year except 1876, but these were in no years at all numerous, except during the three years 1871–'73: and it will be seen that during these years, in fact during the five years 1869–'73, the disease prevailed among the soldiers at Manzanillo and Bayamo. At all three of these places, in most immediate communication with each other, there were very few cases during the five years 1874–'78, notwithstanding the fact that there were many soldiers at these places, as proved by the large number of admissions to the hospitals. However, at the city of Cuba, at the other distant extremity of the high-road, yellow fever was severe in 1876–'77–'78. Jiguani is much more closely connected with Bayamo and Manzanillo than with Cuba.

CHAPTER L.

MANZANILLO.

This town, founded in 1784, is in the province of Cuba, and is the sea-port of Bayamo and Jiguani. It is said to be an unhealthy place, and very uninviting in appearance. As a port of entry for American vessels it is of little consequence, ranking about twelfth among the fourteen Cuban ports of entry. It has no inclosed harbor, but a roadstead, protected by islands. The Cuban charts indicate that the water is so shallow that a depth of 30 feet is marked 3 miles distant from the shore.

Through the Spanish commission a report was received from the board of health, which furnished most of the following statements:

Manzanillo is situated on the southern shore of Cuba, the sea lying directly west of it. About 1,200 meters, or three-fourths of a mile north, the river Yara flows into the sea. This formerly supplied all the drinking water, but now there are many cisterns. Between the Yara and the town lie extensive mangrove swamps, bathed partly by fresh and partly by salt water, and there are many stagnant pools during the rainy season. To the east hills rise, having an average altitude of 20 meters, about 65 feet. The land towards the south is level. The town is on flat ground, the center having an elevation of 3.5 meters, or 11½ feet. The surface soil is of yellow clay, very adhesive when wet, and very dusty when dry. Porous, stratified limestone abounds. Manzanillo covers 65 hectares, or 160½ acres. The streets are 12 meters, or 39½ feet, wide, straight, and at right angles, forming blocks of four lots, each measuring 20 by 25 meters, or 65 by 82 feet.

TABLE No. 68.—*Population.*

Census.	Whites.	Colored.	Total.	Number of houses.
1862	3,060	2,583	5,643	798
1877	7,880	5,600	13,480	....

TABLE No. 69.—*Deaths for the ten years* 1869–'78.

Year.	Civilians.			Sailors.	Soldiers.
	Whites.	Colored.	Total.		
1869	310	516	826	0	170
1870	271	512	783	0	174
1871	342	492	834	0	275
1872	302	387	689	0	526
1873	435	528	963	0	238
1874	582	937	1,519	0	214
1875	245	398	643	2	816
1876	258	264	522	4	206
1877	218	256	474	0	707
1878	350	271	621	5	482

The civil death-rates for the annual average of the three comparatively healthy years, 1876–'77–'78, were, for the whites, 34.9; colored, 47.14; total population, 40.

YELLOW FEVER.

Peñuela, writing in 1855, reported "yellow fever also attacks, in July, August, and September, recently-arrived Europeans; but during the past year some of the natives have suffered, particularly the children, almost all of whom have died, because it was not believed that such children were liable to the disease; hence the first and second periods were permitted to pass without securing medical aid." Pezuela's statistics, Table No. 47, report a considerable number of cases of yellow fever admitted into both the civil and military hospitals during the five years 1855–'59.

The military hospital statistics, Table No. 46, cover the 28 years 1851–'78, and report no cases until 1855, and then only one case. During 9 of the 28 years no cases are reported; during 12 other years the number of cases ranged from 1 to 36, and apparently there was little prevalence of the disease, except during the five years 1869–'73.

The board of health reported that yellow fever is indigenous and endemic in Manzanillo; that residents who have not visited other infected places are attacked here; that there are no towns very near, only little groups of dwellings; that yellow fever specially prevailed in 1869 and 1872 among the soldiers; that it began in October, 1871, and continued with great and exceptional severity in November and December, 1871, in January and February, 1872, and continuously every month during 1872–'73; and that it usually prevails from June to October inclusive; but its prevalence during the winter of 1871–'72 was due to the arrival of unacclimated troops. The board of health further furnished the following statistics of the deaths by yellow fever during the 10 years 1869–'78; and it is worthy of notice that the deaths of soldiers, reported by the board of health, do not fully concur with the same data reported in the military hospital statistics, Table No. 46. Such discrepancies are characteristic of Cuban statistics.

TABLE No. 70.—*Deaths by yellow fever during the* 10 *years* 1869–'78, *as reported by the Manzanillo board of health.*

Year.	Civilians.	Sailors.	Soldiers.	Year.	Civilians.	Sailors.	Soldiers.
1869	11	0	110	1875	3	2	19
1870	3	0	37	1876	2	0	41
1871	7	0	63	1877	2	0	4
1872	9	0	252	1878	2	4	52
1873	7	0	76				
1874	0	0	11	Totals for 10 years	46	6	665

Whether the sailors here and elsewhere reported belonged to the Spanish navy or to mercantile vessels, or to both, is not stated.

CHAPTER LI.

MARIANAO OR QUEMADOS.

This town, which was certainly in existence in 1762, when captured by the English, is in the province of Havana. It is 6 miles southwest of the city of Havana, with which it has been connected by an excellent railroad since 1863.

Marianao includes the settlements of Marianao (proper); of Quemàdos, on the same ridge, and a half-mile nearer to Havana; of the Playa or Beach, a very small sea-bathing resort; and, in addition, of the country houses adjacent to these settlements. Its chief interest, like that of Guanabacoa, depends on the facts that it is very near Havana; has therewith constant and frequent communication by rail (every hour); is a popular summer resort, and enjoys great reputation for general healthfulness, and specially for its exemption from yellow fever. There is no difficulty in finding intelligent Cuban residents, even physicians, who will give assurance that no one ever has yellow fever in Marianao, unless the disease be contracted elsewhere. For this reason my official instructions rendered it a duty to specially inspect this place.

The chief portion of the population is concentrated at the settlements or towns of Marianao and of Quemados, and the following facts as to Marianao include both places: Marianao is located on a ridge, which runs northeast to Havana, and is elevated 140 to 160 feet above the sea, which, across a beautiful green slope some 2 miles in width, it overlooks. It is the cleanest, most attractive, and beautiful town in Cuba. The natural drainage is unusually excellent. The foundation rocks are limestone; these frequently crop out on the surface, and are in few places, if in any, covered by more than 3 feet of superficial soil.

Some houses have their own supply of good water from wells 20 to 60 feet deep, but a large portion of the population is supplied with water in kegs and carboys, brought from what is said to be a most abundant and excellent spring. This is about an eighth of a mile distant from the settlement of Marianao, down a steep hill, and on the bank of the insignificant river of Marianao, to the west of the town.

The streets, though unpaved, are broad and good. The houses have ample space, are not crowded together, and are much better ventilated than those of Havana. The commanding position of Marianao insures its being well swept by the strong sea breezes, which habitually prevail. As the position is high, dry, and well exposed to the winds, the walls of the houses are dry, and there is no trouble from subsoil moisture. The houses in Marianao are also exceptional in Cuba by the fact that a much more considerable number of them have their ground floor elevated from 1 to 5 feet above the ground. As elsewhere in Cuba, the floors are of brick, stone, marble, some of plank, and some even of earth; these last being common in Cuba among the poor. Some few of the privies are walled with brick or stone, but for the most part these are mere pits excavated in the soil and are rarely cleaned.

Those natives who live on the heights are, as is alleged, little troubled with malaria; however, the summer residents who occupy even these heights do suffer much.

TABLE No. 71.—*Population.*

Census of—	Whites.	Colored.	Total.	Number of houses.
1862	2,062	1,345	3,407	582
1877	....	....	6,863	666

TABLE No. 72.—*Baptisms or births.*

Year.	White.	Colored.	Total.
1877	153	80	233
1878	132	64	196

TABLE No. 73.—*Deaths.*

Years.	White.	Colored.	Total.
1877	152	120	272
1878	163	108	271
Seven months to August, 1879	66	56	....

The resulting death-rate for the whole population is 39.48, a very unfavorable result for a town reputed to be exceptionally healthy.

YELLOW FEVER.

Dr. J. A. Beltran, of the board of health, to whose courtesy many of the above facts are due, reported that the deaths by yellow fever were 8 in 1877, 8 in 1878, and 1 to August, 1879. This small number of deaths might very readily be due to infection in Havana, so investigation had to be made which would determine whether the few unacclimated who never visited Havana, or other infected place, were ever attacked while residing in Marianao. The four chief, if not the four only, physicians in Marianao, Drs. Beltran, Forns, Armona, and Morado, gave their cordial and valuable aid to the investigation.

In the first place, inquiry of Dr. Beltran, who has a large practice, failed to secure from him the specification of the names of any unacclimated persons in the town. Dr. Forns stated that the unacclimated population was about 500, and was kind enough to furnish a detailed list of 65 of these 500. An analysis of this list of these 65 so-called unacclimated residents of Marianao developed the following facts: Nearly all were males and adults who had resided from 6 months to 40 years in Marianao, but only eleven of the 65, less than 2 years. The average duration of the residence of the whole 65 was 13 years—certainly a most unfavorable class of unacclimated inhabitants from which to draw any inference as to their liability to yellow fever, above all by a physician in practice among them only 11 years. From these facts the conclusion is inevitable, that the residents of Marianao who have never had yellow fever, or are unacclimated, must be comparatively very small.

Dr. Beltran reported the following five cases:

I. José Blanco, a Spaniard, aged 16 years, was attacked by yellow fever in Marianao, although he had not been to Havana nor away from Marianao for a month preceding his attack. It may here be stated that while in Cuba attention was paid to the period of incubation of yellow fever, or the interval between exposure to the poison and the first symptoms of the disease. Although a number of good instances were collected, there was not one in which this period exceeded six days, and for the most part the period was two to four days.

II. M. Martinez, a Spaniard, died of yellow fever December 10, 1877. He had not visited Havana, so far as could be learned.

III. A. Cruz, a Cuban blacksmith, aged 19 years, a native of Guatao, an inland village about 8 miles southwest of Marianao, had resided 3 years in Marianao, and was attacked with yellow fever October 29, 1877, on returning from a visit to his sick father at Guatao. His father's disease is not known. He had not visited Havana nor any other place except Guatao.

IV, V. A Spanish lady with two children, a little girl and a boy 2 years old, came to Marianao. After residing here three months both children sickened on the same day with yellow fever and died. There is no reason to believe that either the mother or the children had been away from Marianao during their three months' residence.

Dr. Beltran cited other cases, but these had visited Havana recently, and therefore are unsatisfactory.

Dr. José Forns, who has practiced in Marianao 11 years, and longer than any other physician there, reported: "The alleged exemption of Marianao from yellow fever is relative not absolute; for annually there are some victims to this endemic. The number is exceedingly small among the well-to-do, whose hygienic surroundings and mode of life are excellent, and who refrain from visiting infected places. The cases contracted here are among those subjected to continuous labor, and who live in damp, dirty places, in an atmosphere deteriorated by emanations from the half-rotten fruit-food they generally use. I have seen here one undoubted case of yellow fever in a young man who was born and had lived most of his life in a town near Marianao." This probably is Dr. Bertran's case III. "Probably nineteen in twenty of the cases of yellow fever in Marianao are contracted by visiting Havana. I have never had a case in a native resident of Marianao."

Dr. Armona does not believe that Cubans ever have yellow fever, but that physi-

cians mistake bilious fever in natives for yellow fever; and he reported: "I have never seen a native resident of Marianao attacked by yellow fever, and I have never seen yellow fever attack any person here who totally abstained from visits to Havana and other infected places."

Dr. Enrique Morado, the junior practitioner in Marianao, reported the following facts: "I attended a Spaniard, aged eighteen years, who died of yellow fever in Marianao. He arrived at Sagua la Grande, Cuba, when five years old, returned to Spain when ten years old, and when about fourteen years old returned to Sagua, and after remaining there three years came to Marianao. Six months thereafter, and without having visited any other place, he was attacked with yellow fever and died on the tenth day." Dr. Morado also saw Dr. Beltran's case III of A. Cruz, and of these two cases he carefully details the symptoms, at the same time furnishing diagrams of their daily pulse and temperature in proof that both cases were of undoubted yellow fever. In truth, none of the prominent and characteristic symptoms of the disease were wanting in either case. So that, as one of his colleagues stated in respect to the Cuban, A. Cruz, only one thing was lacking to make the diagnosis of yellow fever perfect, viz, foreign birth. "These two cases were neither of them natives of Marianao, but both contracted the disease here and proved the presence here of the poison. Why should Marianao enjoy the immunity attributed to it? It is reasonable to suppose that its elevated and topographical situation, the purity of its waters, and the good habits of its residents should cause the cases to be less numerous, but to deny the presence of the poison is to deny the reality of facts."

All of the four physicians concur in believing that Marianao is comparatively free from the poison of yellow fever. In support of this view is the following report from the Rev. Father B. Viñes, the accomplished chief of the observatory of the Royal College of Belen, Havana, and the possessor of a mind of wonderful clearness and scientific accuracy: "This college of the Jesuit Fathers was established in Havana in 1853. The number of unacclimated persons from Europe average about six annually. During the fifteen years 1853–'68, there had been 55 cases of yellow fever, 9 cases of acclimating fever, and 13 deaths; but during the eleven years 1869–'79, there have been only 17 cases of yellow fever, 3 cases of acclimating fever, and one death. This solitary death occurred in a father who did not belong to this community, but was in transit from Texas. He arrived very late in the season, for which reason the usual precautions were not taken; he died in October.

"The change in circumstances and the precautions which have been taken, particularly in recent years, and to which is perhaps to be attributed in great measure the fact that the number of cases and deaths have become much less, are principally the following:

"1st. The termination of the course of study at the end of June, instead of, as formerly, at the end of July; together with lighter work required of the young men, especially after the close of the course.

"2d. A diminished number of the unacclimated, due to the fact that effort is now made to send here only acclimated youths.

"3d. Since 1872 the dwellings have been improved, and the new apartments are larger, cooler, and better ventilated.

"4th. Also, since 1872, we have rented a country house at Quemados de Marianao, on high ground, open, cool, and well ventilated by the breezes. New comers from Europe are sent here without loss of time, remaining two or three weeks, and not beginning work in the College at Havana until the end of September. Those who are unacclimated pass here all of their vacation, from the end of June to the end of August. Formerly they had only three weeks' vacation.

"Since renting this country house, in 1872, not one, while staying there, has been attacked with yellow fever. However, no precautions whatever are taken respecting the contact or non-contact of the acclimated, or of those attacked by yellow fever, with those who are unacclimated. So little attention is paid to this, that cases convalescing from yellow fever are sent from Havana to the country house, even when the unacclimated are there."

Marianao presents, then, an example of a high, dry, well ventilated place, fully exposed to the strong trade-winds, and in 6 miles of Havana, which is comparatively free from the poison of yellow fever. Almost every habitually infected place can present similar examples. But the effort to prove that the poison cannot be, and has never been, transported to Marianao, is not sustained by the facts now presented.

CHAPTER LII.

MARIEL.

This town, founded certainly as early as 1762, is in the province of Havana and about 28 miles west of the city of Havana. It is located on the east bank of the

harbor, of the "first class," of Mariel, but it is not a port of entry. The population in 1862 was 957, viz, 617 whites and 340 colored.

No reports were received from this place, except from the military hospitals. The statistics from these embrace only the eleven years 1857–'67, which show no cases of yellow fever among the soldiers there stationed during seven of these eleven years; no prevalence of the disease, except during the four years 1861-'65, and no serious prevalence during any of these four years, except in 1861, when, of 300 patients admitted, 113 of them were cases of yellow fever. Mariel is a place of no commercial importance, and has no railroad communications.

CHAPTER LIII.

MATANZAS.

Matanzas signifies "slaughtering place," and this city, so named, because originally a cattle-farm, was first regularly settled in 1693. It is in the province of Matanzas, 54 miles west of Havana, by the most direct of the two railroads which unite these cities. It is located on the western inland extremity of the Bay of Matanzas, a harbor of "the first class." This city was personally inspected, and invaluable aid received from Dr. E. A. Calves, a native and resident physician of distinction, educated in the United States.

Matanzas is subdivided into three districts, viz, the central district of Matanzas, which, some ten blocks or a half mile in width across the center of population, lies between the two little rivers, San Juan to the south, and the Yumuri to the north; the Pueblo Nuevo district, south of the San Juan, and around the inland extremity of the harbor; and the district of Versalles, north of the Yumuri, nearest to the open sea, as also to the anchorage ground, and, sanitarily, the best located district of the city. About two-thirds of the population are in the district of Matanzas, and the Pueblo Nuevo district has nearly double the population of Versalles. Pueblo Nuevo is located on ground originally a swamp; it is low, flat, and only 2 to 4 feet above the sea. The Matanzas district has many houses on equally low ground, on the harbor's front, and on the banks of the two rivers which inclose this district; but from the front, and between these rivers, the ground ascends, so that its houses are located from 2 to even 100 feet above the sea; however, the center of population, the public square, is only about 20 feet above sea level. Versalles is located on a bluff of the harbor, and its houses are situated, for the most part, from 15 to 40 feet above the sea.

Taking the city as a whole, it is very beautifully located within an amphitheater of hills from 100 to 200 feet high. Its general appearance is decidedly attractive.

DRAINAGE.

The district of Matanzas has, as was alleged, ill-constructed and useless sewers in only two streets, and no houses connected therewith. So much of this district and of Versalles as is built on the hill-slope, is naturally well drained, and probably one-half of the total population enjoy this advantage; but the Pueblo Nuevo district, and those parts of Matanzas built in immediate proximity to the banks of the rivers, are very ill-drained.

WATER SUPPLY.

Since 1872 Matanzas has had an aqueduct from the Bello Spring, 7 miles distant. The supply is alleged to be both abundant and excellent. But of the 4,710 houses in the city, 840 are located on hills outside of the zone supplied by the water-works, while of the remaining 3,870 houses within this zone only about 2,000 get their water from the water-works company, which charges $3, gold, per month for the use of one faucet. Hence more than one-half the houses of Matanzas, 2,710, do, for the most part, get their supply in kegs by purchase in the streets. There are a few public fountains, as also some dangerous wells. Thus, in Matanzas, as in other Cuban cities, the well-to-do, whose sanitary conditions least need rectification, have in their houses an abundant supply of good water, while the poor, whose sanitary evils are greatest, are very ill supplied. In this perspiring climate the cleanliness requisite for health and for decency demands a superabundant supply of water for all classes, and especially for the poor. Personal inspection of a number of houses of the poor working class disclosed invariably a defective water supply. In several instances barrels of rain water, repulsively abounding in wiggle-tails and tadpoles, were found in the back yard, and on inquiring if used to drink, the answer was yes, without the least manifestation of discontent or repugnance. Thus, this was evidently a matter of common and prolonged habit. It was found that the water-works company daily sold, at one cent each, 15,900 kegs of water containing 5 gallons each.

STREETS.

These, more spacious than those in intra-mural Havana, are 30 feet wide, with 24 feet wagon-way. Few streets are paved, some are very poor roads, but, for the most part, these roads are in good condition. In the Matanzas district some of the streets are of solid stone, the natural foundation-rock of the place; for the superficial soil is so thin that the foundation-rocks, which are of extremely porous limestone, abounding in admirable shell-fish fossils, often crop out. Of this very porous rock most of the houses are built.

Across the district of Matanzas, parallel with the harbor and about six streets therefrom, runs Ayuntiamento street from the San Juan to the Yumuri River. At the Yumuri extremity of this street, within seven blocks of the plaza, governor's palace and heart of the city, is located the dumping-ground, which contained a stinking, repulsive pile of refuse and garbage about 100 feet long, 40 feet wide and 8 feet high. This is the only exceptionally disgusting spectacle encountered in the streets of Matanzas.

HOUSES.

These have wider fronts, larger air-space in the rear court-yards, are not so crowded, and are better ventilated than the houses of Havana. As usual in Cuba, the ground-floors are generally on a level with the sidewalk, and some are even below the level of the streets. Plank floors are more numerous than in Havana, and in the only instance which presented an opportunity for examination the plank floor rested about 3 inches above the very damp soil. A good rain floods many of the streets of Matanzas, so that the water runs back into and beneath the houses. Probably one-half the population live where the subsoil water is within 2 to 4 feet of the surface. Even houses built on higher ground have moisture-marks high on the walls. This moisture-mark is due, in part, to saturation of the soil by the foul fluids of privies and of slop-water reservoirs, for the privies and such reservoirs are the same in Matanzas as in Havana and elsewhere in Cuba. The porous limestone, of which most of the houses are constructed, greatly favors absorption.

HARBOR.

This harbor, of the first class, is about 2¼ miles long on its northwestern, and about 5 miles long on its southeastern shore; about three miles wide at its entrance, and 1¼ miles wide at the anchorage-ground. This extends from opposite Versalles out towards the sea, and is from one-third to two-thirds of a mile from the shore; however, some small vessels may anchor within 200 yards from the shore, while other vessels may lie out a mile distant. Mr. Sanchez, an experienced ship-agent, testified that the ships which anchored farthest from the town were the least frequently infected. It is alleged that the sea and land breezes prevailing in summer very rarely blow in the direction from the city to the shipping.

There is but one wharf. This extends from the center of the district of Matanzas, midway the San Juan and Yumuri Rivers. It is in rotten, dilapidated condition, extends some 200 feet out into the harbor, and has some 6 to 8 feet depth of water, permitting only small coasters and lighters to moor at it.

The shipping in this harbor, though not infected as often as at Havana, has often suffered disastrously; and, in view of the proposals to rectify the evil conditions of the harbor of Havana by artificial canals, the following facts as to the harbor of Matanzas deserve consideration: It is a very large body of water compared with the harbor of Havana, and receives the refuse from a city only one-fifth the size of Havana, hence its comparative pollution is insignificant. Again, the entrance to this harbor is its widest and deepest part, thus permitting free ingress and egress of water. Three rivers empty into it. The largest is the Canimar, nearer the sea than Matanzas, and therefore, sanitarily, of no consequence; but the San Juan and the Yumuri are rivers of considerable size, especially the former, and so located that their streams should play an important part in freshening the water of the harbor. It is, however, to be noted that the San Juan, 100 feet wide, and the Yumuri, about 40 feet wide at the city, are at this place inlets of the sea rather than independent rivers, for, if either be ascended to where tide-water ceases they are found to be comparatively insignificant streams, as are all Cuban rivers. Three miles from Matanzas the San Juan, much larger than the Yumuri, is only about 25 feet wide and 8 feet deep, which, however insignificant, suffices none the less to teach how very little benefit could be expected from directing the Almeadares River into the harbor of Havana.

BALLAST.

This consists of rock of many kinds, granite, selenite, sandstone, limestone, &c., with sand and pebbles intermixed. It is obtained from Europe, South America, and from the adjacent hills of Versalles. It is deposited in an open lot on the San Juan River, at the foot of Ayuntiamento street, and therefore in the midst of a center of

population. The pile is some 15 feet high, and its base gives evidence of frequent fæcal and urinary deposits. It is generally kept in store for three or four months, is rarely used except from June to November, when there is little export trade; and, as was reported, is used most frequently by vessels bound to southern ports of the United States. It is conveyed in lighters down the San Juan to vessels in the harbor.

TABLE No. 74.—*Population.*

Census of—	Whites.	Asiatics.	Colored.	Males.	Females.	Total.	Number of houses.
1846	....	....	....	....	....	17,860	2,942
1862	18,583	....	11,956	....	....	30,539	....
1877	26,329	1,314	9,504	20,348	16,799	37,147	4,710

The population of the three districts were officially reported as follows: Matanzas, 23,702; Pueblo Nuevo, 8,956; Versalles, 4,606.

TABLE No. 75.—*Baptisms, or births.*

Year.	White.	Colored.	Total.
1877	1,106	420	1,526
1878	1,014	396	1,410

TABLE No. 76.—*Annual mortality statistics of Matanzas for the 21⅔ years, January,* 1858, *to August* 25, 1879, *from the church registers.*

Year.	White.*	Colored.	Total.	Remarks.
1858	1,330	755	2,085	Yellow fever and small-pox.
1859	769	491	1,260	
1860	810	460	1,270	
1861	1,089	802	1,891	Small-pox January to October.
1862	698	426	1,124	
1863	698	411	1,109	
1864	781	383	1,064	
1865	783	741	1,524	
1866	1,044	759	1,803	Small-pox from August, 1866, to April, 1867.
1867	1,087	557	1,644	
1868	1,050	791	1,841	Cholera, February to November.
1869	838	512	1,350	
1870	1,425	1,137	2,562	Cholera, August and September.
1871	1,295	969	2,264	Small-pox, January to September.
1872	701	468	1,169	
1873	887	458	1,345	
1874	949	493	1,442	
1875	1,018	619	1,637	Small-pox, January to December.
1876	1,182	624	1,806	Small-pox, January to July.
1877	1,066	467	1,533	
1878	1,145	478	1,623	Yellow fever severe.
First 8 months of 1879	775	428	....	Small-pox, April to August.

*Asiatics included with the whites.

The distribution in the three districts, of the deaths, as registered in the three churches, in 1876-'77-'78, was as follows:

TABLE No. 77.

Districts.	1876.			1877.			1878.		
	White.	Colored.	Total.	White.	Colored.	Total.	White.	Colored.	Total.
M tanzas	540	367	907	475	295	770	528	284	812
Pueblo Nuevo	369	160	529	277	114	391	266	110	376
Versalles	273	97	370	314	58	372	351	84	435
Totals	1,182	624	1,806	1,066	467	1,533	1,145	478	1,623

DEATH-RATES.

The death-rates for the annual average for the three years 1861-'62-'63, and 1876-'77-'78, were as follows:

TABLE No. 78.

	Whites.	Colored.	Total population.
1861-'62-'63	44.61	45.67	45.02
1876-'77-'78	40.91	56.08	44.52

The death-rates of each of the three districts during the three years 1876-'77-'78 were as follows: Matanzas, 35.02; Pueblo Nuevo, 48.23; Versalles, 85.02. This unfavorable result, as to the district of Versalles, believed to be the healthiest part of the whole city of Matanzas, is doubtless due to the fact that the public and private hospitals are located in this district. However, even after deducting on this account all which the reports in my possession indicate, Versalles is still left with a disproportionate and unexplained excess of deaths.

The deaths in the civil hospital in Versalles, were as follows during the 17⅔ years January, 1862, to August 25, 1879:

TABLE No. 79.

1862	62	1868	69	1874	105
1863	71	1869	109	1875	108
1864	74	1870	151	1876	162
1865	67	1871	120	1877	121
1866	88	1872	80	1878	179
1867	104	1873	119	Eight months 1879	158

DISEASES.

The following table of cases and deaths by diseases was copied from the records of the board of health, and is presented as a specimen of Cuban mortality statistics. It includes some deaths in the jurisdiction outside of the city of Matanzas, and is compiled from such reports as physicians see fit to forward, in obedience to the law, which many neglect to comply with. How many neglect this may be estimated by the fact, that although the following table includes some cases and deaths outside of the city, the deaths amounted in 1878 to only 845, according to the board of health; while there were registered in the churches 1,623 deaths in 1878. The table is, however, calculated to give some idea of the relative prevalence of the diseases specified.

TABLE No. 80.—*Cases and deaths of various diseases in Matanzas in 1878.*

[Compiled and copied from the records of the board of health.]

Diseases.	Cases.	Deaths.	Diseases.	Cases.	Deaths.
Inflammations, internal	1,016	163	Phthisis, various	401	156
Febrile phlegmasias of skin	380	2	Dementia	97	3
Visceral neuralgias	353	0	Hypertrophies	81	15
Clonic spasms	70	15	Asphixias	5	3
Tonic spasms	86	41			
External neuralgias	521	0	Totals	13,309	741
Dropsy	281	61			
Hemorrhages and other fluxes	314	17	EPIDEMIC AND CONTAGIOUS DISEASES.		
Typhoid fever of Chomel	230	53			
Fever, catarrhal	3,060	2			
Fever, intermittent	2,573	74	Cholera morbus	0	0
Anginas diverse	544	17	Colerina	4	3
Diarrhœa	1,224	60	Small-pox	30	4
Dysentery	528	52	Yellow fever	301	97
Ophthalmia	307	0			
Rheumatism	1,238	7	Sum total	13,644	845

While the above official printed form of the reports of the board of health admits only four fevers, viz, intermittent, catarrhal, typhoid, and yellow fever, yet it was found that physicians also certified to "remittent, bilious, pernicious, malignant, ataxic, adynamic, nervous, gastric, cerebral, puerperal, hectic, and miliary fever."

A critical examination of the monthly statistics for several years served to show that the so-called "pernicious" and "malignant" fevers always prevailed most when yellow fever did, and that the maximum deaths by these diseases occurred when yellow fever was most fatal, rather than when malarial fevers were. This result seems explicable in no way except by the fact that many physicians in Matanzas, as elsewhere, refuse to believe that Cuban children or adults can have yellow fever. For them all such cases are pernicious, or malignant, or bilious, or typhoid, or any fever rather than yellow fever.

Examination of the above table confirms this view. Matanzas suffered very severely by yellow fever in 1878, and yet while there are recorded in the above table only 301 cases and 97 deaths of yellow fever, an unusual number of deaths are reported by intermittent fever, and 230 cases and 53 deaths by typhoid fever. This is incredible, especially as to typhoid fever, which my researches in Cuba failed to find by any means frequent. Many physicians of Cuba openly accuse many of their confrères of covering up, from "ignorance and interest," their cases of yellow fever, and such is the conviction left on me by study of the mortality statistics of Matanzas for a number of years.

The above table shows, as usual in Cuba, a greater mortality by consumption than by yellow fever or by any other disease. It also shows a vast number of cases, not quite one-half of the whole, of catarrhal and intermittent fevers. Dr. Calves asserted his conviction that two-thirds of all cases of sickness were due to malarial poison; and that while it existed everywhere it was especially prevalent in the Pueblo Nuevo district and on the banks of the rivers.

YELLOW FEVER.

Matanzas has the reputation of having long suffered annually with yellow fever; the earliest positive date secured by me was reported by Dr. Guiteras, a member of the American Commission, and a native of Matanzas, who was assured by one of the oldest physicians that the city suffered with the disease in 1828, when he first came to Matanzas, and had prevailed every year since. There is reason to believe that the disease annually prevailed long anterior to 1828.

Peñuela, writing in 1854, enumerates yellow fever among the endemic diseases of Matanzas and of its jurisdiction. Pezuela's statistics, Table No. 47, of the five years 1855–'59, report an annual average of 434 cases in the civil and of 194 cases in the military hospital. The military hospital statistics, Table No. 46, embrace the twenty-eight years 1851-1878, and report no cases during the four years 1852–'53–'54, and 1866; and that the cases were most numerous in 1857–'58, 1860, 1862, 1864–'65, 1869, 1875–'76, and 1878.

The following imperfect report of yellow fever in the civil population is the best which could be procured from the records of the Matanzas board of health. Although the report purports to cover the twenty-three years 1857-1879, yet for five of these years, 1857, 1866, 1869, 1870, 1879, it is defective, not covering the full twelve months. While this table may serve to indicate the comparative prevalence of yellow fever in different years, it is unreliable for other purposes, and for the following reasons:

Only in 1877–'78–'79 are the figures reported for Matanzas alone, since other years include cases occurring in the surrounding country. Dr. Calves, a distinguished and thoroughly reliable resident physician, stated that the board of health obtained its data from only those physicians who saw fit to report, and that many physicians, having neglected to comply with the law requiring all cases of yellow fever, among other "epidemic and contagious diseases," to be promptly reported, did not, in case of fatal issue, hesitate to indicate on the certificate some other disease non-epidemic and non-contagious; and, farther, that while some physicians were prone during the warm season to diagnose every case of fever as yellow fever, there were others who never diagnosed this disease unless albuminuria confirmed the other symptoms. In addition, it should not be forgotten that as proved for 1878, so for other years, the board of health succeeded in reporting only about one-half of all the deaths registered by the

churches. For such reasons the yellow fever cases and deaths were probably much more numerous than reported in the following table:

TABLE No. 81.—*Yellow fever cases and deaths in the civil population of Matanzas from July, 1857, to August, 1879, as recorded by the board of health.*

Years.	Cases.	Deaths.	Remarks.
1857, six months of	426	162	Only for July to December, 1857.
1858	846	345	Of these, 149 cases and 53 deaths in January.
1859	84	22	
1860	192	49	
1861	218	50	
1862	262	56	Of these, 77 cases and 18 deaths in January, February, and March.
1863, nine months of	9	1	No records for June, September, October.
1864	768	188	
1865	281	91	
1866, no months of, recorded	*	*	No cases in military hospital.
1867	208	36	
1868	28	7	
1869, four months of	23	10	For March, April, May, June only.
1870, eight months of	18	7	No records for January, February, March, and September.
1871	55	8	
1872	20	1	
1873	329	62	
1874	220	47	
1875	24	8	
1876	24	6	In addition, 212 cases of soldiers.
1877	86	21	
1878	301	97	In addition, 299 cases of soldiers.
1879, first seven months of	53	27	

* No records.

Comparison of this table with Table No. 46 will serve to indicate the years of greatest prevalence.

In more than half the years reported the disease prevailed in every month, even from November to March, and throughout the winter of 1857-'58 with severity.

Mr. George L. Washington, United States vice-consul at Matanzas, resident there since 1866, and to the courtesy and zeal of whom, as of his brother at Cardenas, much was due, reported the following facts: "During my residence here, yellow fever has prevailed every summer. The worst epidemics in the bay, known to me, were in 1869 and in 1878. In some years the shipping has been exempt. In 1878 the shipping suffered severely, but in 1879, to August 11, no case whatever occurred in vessels anchored here, except on several arriving infected from Havana. Yellow fever is supposed to be indigenous here, but I have noticed that the first cases in the bay are usually from Havana, or on vessels lying near those from Havana. Native residents are exempt from the disease, but natives from the interior have been infected here."

In 1879 yellow fever was very much less severe in Matanzas than in 1878, probably because there were fewer unacclimated inhabitants, for the disease was severe in 1879 in Havana, and exceptionally violent in Cardenas. In addition to data already cited, the following indicate the comparatively slight prevalence in 1879. At La Cosmopolita, a private hospital, the yellow fever cases and deaths, 1876-'79, were as follows: 1876, 32 cases and 10 deaths; 1877, 34 cases and 10 deaths; 1878, 119 cases and 46 deaths; eight months of 1879, 5 cases and 1 death.

The garrison of Matanzas consisted in 1879 of 910 officers and soldiers, for the most part of the first battalion of the regiment "Reuss." As the soldiers were reported to have suffered little or none by yellow fever, information was solicited of the surgeon, and the following facts obtained in respect to 682 of the 910:

52 had served in Cuba more than three years.
150 had served in Cuba three years.
180 had served in Cuba two years.
300 had served in Cuba less than one year.

682

From June 27, 1878, to July, 1879, these soldiers had been stationed in Fort Cabañas, Havana, and during said twelve months had there had 229 cases and 86 deaths of yellow fever Of the above 300 soldiers, in Cuba less than one year, all had been in Fort Cabañas at least four to six months. Evidently there were not left in this battalion of

soldiers many who had not had yellow fever. These soldiers arrived in Matanzas July 15, and to August 26 there had been 46 cases and 20 deaths of yellow fever, as many as preceding facts would have justified us in expecting, so that there was nothing to justify the prevalent belief that absence of an epidemic in 1879 was due to absence or mildness of the poison, but rather to lack of unacclimated material.

An instructive incident, occurring in Matanzas, deserves record, as illustrating a common occurrence in Cuba, as in every country where yellow fever prevails so habitually that residents become accustomed and indifferent to its ravages.

Calling on the military governor, a distinguished Spanish general, I was received with great courtesy and furnished every means to acquire full information; hence, what the governor erroneously stated was assuredly said innocently and in good faith. None the less, he did assure me that his garrison of 600 to 900 soldiers had thus far had only two to three cases of yellow fever. Such authority would surely justify any one in stating that from the highest source he had been reliably informed that there was little or no yellow fever in Matanzas in 1879. Yellow-fever literature is full of such "*reliable*" information, with, unfortunately, the falsest inferences drawn therefrom.

Leaving the governor, the army surgeon was visited, and preceding facts, very different from the governor's, were obtained. The hospital was then visited, and there I inspected the tickets of five soldiers dead with yellow fever, and saw several others then lying dangerously sick. So much for the unquestionably honest, but unquestionably erroneous, report of the highest authority in Matanzas.

It would be difficult to find looser, scantier, and less reliable statistical data anywhere than in Matanzas. Even the imperfect data thus far reported were obtained with much trouble and at considerable expense. Finally, it should be mentioned that Mr. H. C. Hall, United States consul-general at Havana, was for many years resident at Matanzas, and testified that for the only time in the memory of man there was frost, on December 24, 25, and 26, 1856, which seems to have been general throughout Cuba.

CHAPTER LIV.

MAYARI.

This village, which in 1862 had a population of 520, is in the province of Cuba. It is located on the west bank of the river Mayari, navigable to the village, and about five miles south of the harbor of Nipe, a harbor on the north coast, between Jibara and Baracoa. Mayari is not a port of entry, nor has the harbor of Nipe any such port. During the insurrection, 1868–1878, this village became a military post of consequence; but, apart from this, the place is of no commercial or other importance.

No information was procured in regard to it, except such as is reported in the military hospital statistics, Table No. 46. These cover, in all, only eleven years, viz, the three years 1862–'64 and the eight years 1871–'78. During the first three years there were very few admissions, and no cases of yellow fever, and during two of the eight years 1871–'78 there were no cases of yellow fever, although the admissions by other diseases were numerous. Only in 1872 and 1874 were there many cases of yellow fever. In 1874, the worst year, there were, of 887 admissions, 57 for yellow fever, while in 1877 there were only 17 cases of this disease, out of 5,186 admissions by all diseases. This very slight prevalence of yellow fever in 1877 is all the more notable because in this year the disease was severe in Holguin, Baracoa, and Santiago de Cuba, the three cities of note nearest to Mayari, and at three different points of the compass. However, Mayari is from 50 to 80 miles distant from these three places, and communication is infrequent and over difficult wagon-roads.

CHAPTER LV.

MORON, OR SAN NICOLAS DE MORON.

This inland village, which in 1877 had a population of 623, is in the province of Cuba, located about 15 miles north of the city of Cuba, and 35 miles southwest of Mayari. It is not to be confounded with a larger town of the same name, 200 miles to the northwest, in the province of Sta. Clara.

Like Mayari, this place is of no interest, except as a military post. No information was obtained respecting it, except such as is reported in the military hospital statistics, Table No. 46. These cover only the ten years 1869–1878. During three of these ten years, there were no cases of yellow fever, which prevailed especially in 1870, 1871, 1876. In 1871, of 2,720 admissions, 405 were of yellow fever, while in 1877 there were only 4 cases in 5,146 admissions.

CHAPTER LVI.

NUEVITAS.

This town, said to have been first settled in 1513 but to have been of little consequence until 1819, is in the province of Puerto Principe, and is chiefly of importance because the seaport of Puerto Principe, the largest inland city of Cuba. With this city Nuevitas is connected by a railroad which runs southwest to a distance of 72.6 kilometers, or 45 miles. A steamship line, which connects Nuevitas with other Cuban ports, halts at this place at least three times a month.

Nuevitas is on the north coast, between the two other ports of entry, Remedios and Gibara, and is located on the west bank of the large harbor of Nuevitas, some 15 miles from the open sea. It is situated on a sharply-inclined plane, so that from its water-front to the upper town an elevation of about 130 feet above the sea is reached. Pezuela reported, in 1866: "The soil over which Nuevitas is built is in part rocky, but more generally clayish in character, so that some streets in the rainy season are almost impassable. The climate is healthy, although during the prevalence of north winds some endemic fevers prevail, and, as there are no swamps in the neighborhood, their causation can only be attributed to the existence of some pits dug by some of the inhabitants to keep water, which is so scarce in this town that in the dry season a pipe sells at $1."

The harbor or bay is described as the second one in size in Cuba, some 57 square miles in extent, and Hazard says: "The entrance to this superb bay forms a narrow cañon of from 4 to 5½ miles long, forming two bays within its limits, one properly called Nuevitas, and the other Mayanabo, into each of which empty two rivers. There are some prominent islands in it, known as Los Ballenatos (Young Whales)." The harbor of Nuevitas is somewhat circular, about 6½ miles in diameter; and Mayanabo, a projecting northwestern horn, is some 13 miles long and 3 miles wide. The harbor of Nuevitas is, on the whole, shallow, though a harbor of the first class. On the official charts a depth of 17 feet is marked nearly one mile distant from the town, and 26 feet more than 2 miles distant, so that foreign vessels must anchor far from the town and have abundance of sea-room; hence the danger of infection is comparatively slight. It is worth noting that the harbor of Nuevitas was the first place in Cuba visited by Columbus, on October 28, 1492. Of the 14 Cuban ports of entry, Nuevitas is one of those of least importance to American vessels.

Two official reports were received from Nuevitas, one from Mr. J. Sanchez, United States consular agent, and the other through the Spanish commission, from the board of health. From these is derived much of the following information.

TABLE No. 82.—*Population.*

Census.	Whites.	Asiatics.	Colored.	Total.	Number of houses.
1862	1,816	....	392	2,208	306
1877	3,842	40	584	4,466	543

Although the above report for 1877 is official, still a second report stated the sum total at both 4,648 and 4,668.

DEATHS.

These in 1878 were reported by the board of health to have been 120 whites, 28 colored, and 148 total population. These figures yield the following death-rates for 1878, viz, 30.91 for the whites, 47.94 for the colored, and 33.14 for the total population.

YELLOW FEVER.

Peñuela, in 1855, reported that the public health is usually good at Nuevitas; that yellow fever occurs exceptionally, only three or four cases annually; and that in 1854 there was only one case, this in the military hospital. Pezuela's statistics, Table No. 47, for the five years 1855–'59, report an annual average of 16 cases in the civil, and 15 cases in the military hospital. The military hospital statistics, Table No. 46, cover twenty-two years, viz, the twelve years 1851–'62 (1863–'68 hospital closed), and the ten years 1869–'78. Prior to 1863 there were four years without any cases, which were not numerous, except in 1852 and in 1855–'56. During the ten years 1869–'78, there were

annually from 1 to 202 cases, the disease specially prevailing 1869–'73 and 1876–'78. In 1875 there was only 1 case in 3,089 admissions, while in 1876 there were 94 cases in only 2,210 admissions.

The board of health reported, September 5, 1879, "We are undetermined whether yellow fever is indigenous or imported. This endemic prevails July to October; however, a few cases occur both before and after those months. Four cases have occurred this year. Few cases occur in private practice. Only one soldier has been attacked this year, and there have been several cases in the marine hospital from a gunboat. The adjacent towns, Baga and San Miguel, have a scanty population, and the natives are acclimated. Spaniards living there are not now having yellow fever, although the local hygiene of said places is very bad." The village of Baga is reported to have had in 1877 a population of 102; it is located about 5 miles south of Nuevitas, on the southern extremity of the harbor; from it a railroad runs 5¼ miles south to the inland village of San Miguel, which had in 1877 a population of 1,371.

Mr. Sanchez reported that "yellow fever prevails annually, July to November, as an endemic. It is believed to be indigenous and not imported. The disease is brought in from other places, but is not contagious. There has never been a case among the natives, and these do not get the disease on visiting infected places. Spaniards are attacked here, even after three years' residence. There are many unacclimated soldiers and marines and a large floating population here. Before the war, Nuevitas and Puerto Principe were rated among the healthiest places in Cuba, but we now have a great deal of malarial, pernicious, and typhoid fever. The adjacent towns are Baga, San Miguel, and Puerto Principe, all of which have yellow fever just as Nuevitas has.

"This year Nuevitas is very healthy, no disease prevailing except malarial fever. There is now here a Russian vessel; all hands on board are both working and drinking hard, but none have yet been sick. The only cases we have had this year were in the marine hospital and from the gunboat Gaceta, which did not come from Havana direct, but has been for some time in this harbor. Some eight men from the Gaceta have died and another is dying. The complement of a gunboat is usually about 30 men.

"The shipping has continued this year free from yellow fever, and during my residence of thirty years here I have never known of the existence of a single case of this disease on board of any American vessel while at this port. There has been much traffic with the United States; at times as many as 10 to 12 American vessels have been here together; yet I never saw or heard of one case of yellow fever on board any of them. The thermometer does not range here in the shade over 85° to 90° F., but this summer has been unusually warm, and the thermometer has ranged from 90° to 95° F."

The Nuevitas newspaper reported, in September, 1879, "Notwithstanding the great heat since June, and the great prevalence of yellow fever at Havana, we, thank God, have had none of the disease here."

CHAPTER LVII.

PALMA SORIANO.

This little inland village, which in 1862 had a population of 214, is in the province of Cuba, located in a mountainous section, some twenty miles northwest of the city of Cuba, and on the high-road to Bayamo.

No information was obtained of this place, except such as is recorded in the military hospital statistics, Table No. 46. These statistics cover only the five years 1874–'78, and report no prevalence of the disease except during 1878, when there were 175 cases of yellow fever among 1,938 admissions. In 1877 there were 1,972 admissions, without one case of yellow fever. In 1878 yellow fever was specially severe in the city of Cuba.

CHAPTER LVIII.

PINAR DEL RIO.

This, the chief town in the Province of Pinar del Rio, was founded in 1772–1776. It is located 190 kilometers, or 118 miles, southwest of Havana, about 25 miles from the northern and 12 miles from the southern sea-coast. A railroad destined from Pinar del Rio has reached Paso Real within about 25 miles. The town is built on the

side and summit of a hill about 20 meters, or 66 feet, high, the altitude above the sea being 50 meters, or 160 feet. In this district there are no ports of entry nor any maritime towns—only shipping piers, where travelers remain a very short time. Hence, reports the board of health, "there has never been a case of yellow fever in the maritime border of this district, which is low, marshy, covered with mangroves, and uninhabitable."

POPULATION.

In 1862 there were 2,000 whites, 1,088 colored, or a total population of 3,088. This number is reported to have been in 1877 about 5,000. The annual mortality is unknown.

YELLOW FEVER.

Peñuela reported, in 1854, "In the town of Pinar del Rio yellow fever occurs as a sporadic disease, and in 1853 there were six cases in the garrison and four among citizens. All had recently arrived from Spain. Five died, and two were attacked while en route from Havana." He also refers to the prevalence of the disease in 1853 and 1854 at Consolacion del Sur, an inland town about 30 miles east of Pinar del Rio, on the road to Havana.

Pezuela's statistics for the five years 1855–'59, Table No. 47, report an annual average of 17 cases in the civil and of 89 cases in the military hospital.

The military hospital statistics, Table No. 46, report only the nineteen years, 1851–1869. During five of these nineteen years there were no cases; during eight other years there were only from 1 to 7 cases; and there was no notable prevalence of the disease except during the years 1854, 1857, 1859 (severest), and 1869. In 1858, of 826 admissions, there were no cases of yellow fever; but there were 96 cases of 434 admissions in 1869.

Dr. Argumosa (pp. 68–70, vol. 1, 1875, Cronica Medico-Quirurgica de la Habana) published a report respecting the region of country about Pinar del Rio to the following effect: In the lowlands near the sea-coast intermittents prevail, and bilious fever, dysentery and entero-colitis occur in the summer. In this section tubercular, scrofulous and rheumatic diseases are rare, phthisis very rare. There are no large cities; Pinar del Rio is the largest town, and next in size is Consolacion del Sur, while all other towns are quite small. Hence there is no aggregation or density of population to explain the causation of disease. The great sociability of the people, and the rapidity and frequency of their intercourse on horseback, are "sufficient to transmit the different contagious diseases, such as small-pox, measles, yellow fever, and diphtheria, none of which are endemic in this section of country."

The board of health reported in 1879, through the Spanish Commission, as follows: "Yellow fever rarely shows itself here, and no data exist respecting past epidemics. Not a single authentic case has ever developed spontaneously in this town or district. The first cases always proceed from visits paid by persons, shortly before their attacks, to infected places. While not endemic, the disease has in some summers occurred as an epidemic, imported from an infected place. In no one of our epidemics have the deaths exceeded 20 inhabitants. Not more than 25 immigrants settle here per annum, and as epidemics have only occurred every four to five years, not more than 100 inhabitants are exposed. We have never heard of any native having been attacked, and negroes do not have the disease, although living in the worst hygienic conditions.

"Every epidemic has always commenced with persons arriving from an infected place. Those attacked have always been foreigners, and if these foreign-born residents avoided contact with infected persons, they would escape the disease, for, it never develops here spontaneously.

"There has been no garrison of troops here since 1869 until this year, when we have 400 soldiers. To August 31, 1879, there have been 7 deaths by yellow fever, 4 soldiers and 3 civilians. The first case was attacked on July 24. None were natives of Cuba, and all came from Havana. Thus far, residents have escaped, and as the hospital is located on the highest ground to the west of the town, it is probable that the disease will be limited to the recently-arrived soldiers.

"At present none of the towns of the Vuelta Abajo [province of Pinar del Rio] suffer from yellow fever, which is an extremely rare, if not unknown, disease.

"On December 25, 1868, the thermometer here descended to the very exceptional point of 10° C. (50° F.); in all subsequent winters the extremes have been 14°–16° C. (57.2°–60.8° F.) During summer, in well ventilated rooms and in the shade, the extreme temperature is 33° C. (91.4° F.); but this maximum is reached only in July."

As seen, Pinar del Rio has little yellow fever, and little, as well as difficult, commercial intercourse with Havana or other infected place.

CHAPTER LIX.

PUERTO PADRE.

No inhabited place by this name has been found. The harbor of Puerto del Padre is on the north coast, between Nuevitas and Gibara, and is one of the largest and best harbors in Cuba. There are no towns of any size, nor any port of entry, on this harbor. No information was received respecting it except as reported in the military hospital statistics (Table No. 46), which indicate the existence of an encampment on this harbor during the five years 1874 to 1878, when there were, of 5,554 admissions to the military hospital, only 8 cases of yellow fever, 3 in 1875 and 5 in 1876.

CHAPTER LX.

PUERTO PRINCIPE.

This city, founded in 1515, is in the province of Puerto Principe, and was long the second city in size in Cuba. By the census of 1877 it now ranks after Havana and Cuba, having, however, only 156 less population than the latter. It is further inland than any place of note in the island, being about 35 miles from the northern, and 45 miles from the southern coast. A railroad connects it with its sea-port, Nuevitas, 45 miles northeast; 45 miles south of it is the port of entry, Santa Cruz, but the communication therewith is over a difficult wagon-road.

Pezuela states that this city is located on a broad, sandy savannah, at considerable elevation above the sea; and Hazard describes it as the quaintest, most antiquated town in Cuba, a relic of the middle ages, having narrow, tortuous streets, many being unpaved and without sidewalks. It is situated in the heart of the grazing and cattle-raising country, from which business it derives its importance. Puerto Principe has no mountains to cut off the sea breezes.

POPULATION.

In 1842 the population was 24,034, in 1862 it was 30,585 (whites 18,216, colored 12,371), and in 1877 it was 40,679.

Although special reports from this important city were solicited, none were received, due probably to the insurrectionary excitement then prevailing in this section.

In Havana well-informed physicians, as well as non-professional residents, asserted that Puerto Principe had never suffered with yellow fever, because of its elevated, salubrious location and distance from the sea, until the insurrection of 1868–1878. How great an error this was will now be shown.

Pezuela's statistics for the five years 1855–1859 (Table No. 47), report an annual average of 203 cases in the civil, and of 237 cases in the military hospital. The military hospital statistics (Table No. 46) cover the twenty-eight years, 1851–1878, and report some cases of the disease every year, except one, 1866, when there was less of the disease throughout Cuba than in any year reported. During nine other years there were only 3 to 46 cases. There was considerable prevalence of the disease in 1851, 1854–1859, 1865 (the severest), 1869–1874, and 1876–'77. In 1864 there were only 8 cases in 4,103 admissions, while in 1865 there were 739 cases in 3,613 admissions.

CHAPTER LXI.

REGLA.

This town, founded in 1714, is in the province of Havana, and located on the eastern shore of the harbor, and directly opposite to the central part of the city of Havana. The intervening harbor is, at this point, 1,050 yards, or three-fifths of a mile wide, and is traversed in a few minutes by steam-ferries which run several times every hour. While all of the western shore of the harbor, as also a part of the northern sea-shore, is occupied by Havana, the eastern shore of the harbor, much more extensive, because of two deep indentations made in it, by what are called the "ensenadas" or coves of Marimelena and of Guasabacoa, is occupied in only small part, and by the two

settlements of Casa Blanca and of Regla. These are separated by the bay of Marimelena, about three-fifths of a mile wide. Casa Blanca, nearest the harbor's entrance, is one of the wards of Havana, as Regla was for a long time; hence, the population and deaths of Regla have in the past been included in those of Havana. But, for some years now, Regla has been separated from Havana, and therefore must be so considered.

Built upon a slope, the natural drainage is good; however, art has aided nature so little that the drainage cannot be said to be good. The town has a dilapidated, uncared for and filthy appearance. Built on a tongue of land projecting between the coves of Marimelena and Guasabacoa, it is very near to their shores of mangrove marshes, which are very extensive around the bay of Marimelena. Hence, Regla is much exposed to malaria. In Regla, itself, is a much-used, and, in a sanitary point of view, a very badly-located depot for ballast. There are, in all, some five different depots for ballast located along the eastern shore of the harbor of Havana, none of which should be regarded with so much suspicion as the much-used one at Regla, and the one, now little used, at Casa Blanca.

POPULATION.

The population was "about 2,000" in 1812; 5,693 in 1827; and about 9,600 in 1862. Census of 1877: white, 8,983; colored, 2,048; total, 11,031.

The unacclimated population is small, and, so far as yellow fever is concerned, Regla is a part of, and in no wise better off than Havana. The following statistics prove that its general sanitary condition is even worse than that of Havana, as a whole, probably illustrating the condition of some of the worst wards in Havana.

TABLE No. 83.—*Mortality by diseases in Regla, in 1878 and 1879, by Dr. A. G. Del Valle.*

Diseases.	1878.	1879.	Diseases.	1878.	1879.
Alcoholism	2	1	Measles	1	0
Anthrax	1	0	Meningitis	16	13
Cerebral diseases	8	19	Phthisis	98	102
Diarrhœa	36	27	Pneumonia	16	18
Dysentery	2	1	Small-pox	126	56
Diphtheria	1	1	Tetanus	4	5
Eclampsia	7	11	Tetanus, infant	27	21
Fevers:			All other diseases	95	91
Bilious	1	4			
Paludal	39	12	Totals	558	464
Typhoid	9	9			
Yellow*	24	17	Whites and Asiatics	418	339
Heart disease	20	26	Colored	135	125
Hepatic disease	20	30			

* "June 16, 1878, Dr. Lluria certified the death by yellow fever of a child three years old born in Havana."

As above shown, phthisis, small-pox, and malarial fevers are the worst enemies of Regla's native population. Negroes are especially liable to the two former; hence, probably, their high death-rate.

DEATH-RATES.

	White.	Colored.	Total.
1878	46.52	65.91	50.12
1879	37.73	61.03	42.06

CHAPTER LXII.

REMEDIOS.

This town, founded in 1515, is in the province of Santa Clara. It is on the northern coast, 8.5 kilometers or 5¼ miles from its sea-port, Caibarien. A railroad, destined for Sancti Spiritus, is completed from Caibarien via Remedios, some 28 miles southwest, to San Andres. Remedios is elevated 60 feet above the sea.

Reports were received from Dr. P. de Elizalde and from the mayoralty, through the Spanish Commission. From these the following information is for the most part derived.

TABLE No. 84.—*Population.*

Census of—	Whites.	Asiatics.	Colored.	Total.	Number of houses.
1862	4,800	....	2,837	7,637	....
1877	8,547	500	3,405	12,452	1,158

While the above census for 1877 is given in an official manuscript report, yet two other totals were reported instead of 12,452, viz, 13,292 and 13,930.

TABLE No. 85.—*Deaths of civilians.*

	In town.	In country.	Total.	Number by yellow fever.
1878	597	151	748	5
First six months of 1879	204	22	....	1

DEATH-RATE.

As the data reported for the population are discrepant, and those for deaths are confusing as to country and town, no exact estimate can be made. However, Dr. Elizalde reports the annual death-rate to be "about 50." and the mayoralty, *i. e.*, probably the board of health, to be from "40. to 45." It is specially stated as to these death-rates that "no contagious diseases have occurred."

YELLOW FEVER.

Peñuela reported, in 1854, "During the seven years I have practiced in this town I have not seen a single case of yellow fever." But the disease did make its appearance in 1854, for the mayoralty reported that since 1854 yellow fever has annually prevailed here, especially July to October, and Dr. Elizalde reported that the disease was especially severe in 1854, 1855, and 1869.

The military hospital statistics, Table No. 46, cover the twenty-eight years 1851-'78, and report no cases of yellow fever in fourteen of these twenty-eight years, and the first cases reported were in 1857. However, the mayoralty report states specifically that the disease prevailed in 1854 with special severity among the soldiers who were sent to Remedios in order to be acclimated. According to the military hospital statistics, the only years during which the cases were at all numerous were 1857-'58 (instead of 1854-'55), 1869, 1870, 1871, and 1875. This inland town has apparently suffered more than its sea-port Caibarien, which is only a place of transit for soldiers between Havana, as also between other ports and Remedios.

The mayoralty report states that "yellow fever is believed to be indigenous here, but that it does not habitually prevail. There are about 150 unacclimated persons now here and liable; in 1878 only five civilians and four soldiers died here of yellow fever. The epidemic of 1869 attacked especially the native Cuban refugees from the back country. Yellow fever prevails at no adjacent town except at Caibarien, and this is believed to be due to absence of the poison in these towns. A frost occurred here on December 24, 1856."

Dr. Elizalde, writing with twenty-two years experience, reported: "Yellow fever is indigenous here. The average annual number of the unacclimated is probably 40 to 50 persons. Cases of yellow fever occur every year. The majority of those attacked in 1869 were native Cubans, who were refugees because of the insurrection from interior and uninfected towns. Excepting Caibarien, the other towns are inhabited by persons not acclimated, consequently liable to yellow fever; as this never visits them, it is natural to suppose that their exemption is due to absence of the causes which produce the disease."

CHAPTER LXIII.

SAGUA, OR SAGUA LA GRANDE.

This modern town, founded about 1817, is in the Province of Santa Clara. Although a port of entry since 1844, the fifth in importance to American commerce among the 14 Cuban ports of entry, it is none the less 16 kilometers, or 10 miles, from the northern sea-coast, and from its sea-port, Isabela de Sagua. Isabela is at the mouth of the

river Sagua, on the west bank of which the town of Sagua is located. It is about 90 miles east of Cardenas.

The sea-port has no inclosed harbor, but a roadstead protected by islands. By the chart, this roadstead is so shallow that its greatest depth is 15 feet, and this depth is not nearer the shore than 2¼ miles, while a depth of 18 feet is not found until 6 miles distant from the mainland beyond the islands which guard the roadstead. Hence, the anchorage ground must be so distant that ships there run little danger of infection.

A railroad, opened in 1858, runs from Concha, or Isabela, at the mouth of the river Sagua, via the town of Sagua, 10 miles south, to the inland town of Santo Domingo, 49 kilometers, or 29¼ miles, distant. This branch to Santo Domingo links Sagua to the Cuban main trunk line, and thereby with Havana, Matanzas, Cardenas, and Cienfuegos; the distance by rail being 279 kilometers, or 174 miles, to Havana, and south to Cienfuegos 108 kilometers, or 67 miles.

Pezuela states that Sagua is a healthy place, except that malarial fevers prevail in the rainy season. Reports were received from Mr. J. F. Swords, United States consular agent, from Dr. Nicolas de la Peña, to whom special thanks are due, and, through the Spanish Commission, from the board of health. From these sources most of the following facts were obtained.

TABLE No. 86.—*Population.*

Census of—	Whites.	Colored.	Total.	Number of houses.
1829	....	....	463	81
1862	5,833	3,799	9,632	....
1877	72,648	5,905	18,553	....

Of the 12,648 whites in 1877, there were 2,153 Chinese, or Asiatics.

TABLE No. 87.—*Baptisms or births.*

Years.	Whites.	Colored.	Total.
1876	429	202	631
1877	359	224	583
1878	354	210	564

DEATHS.

TABLE No. 88.—*Mortality statistics of Sagua for the 23⅚ years, January, 1856, to November 1, 1879.*

Years.	Whites.	Asiatics.	Colored.	Total.	Years.	Whites.	Asiatics.	Colored.	Total.
1856	223	13	103	339	1868	376	126	288	790
1857	212	2	127	341	1869	270	37	185	492
1858	304	1	104	407	1870	471	122	434	1,027
1859	146	1	70	217	1871	438	44	248	730
1860	159	1	111	271	1872	173	41	124	338
1861	204	4	112	320	1873	227	74	160	461
1862	87	13	87	187	1874	200	72	172	444
1863	127	12	99	238	1875	250	73	173	496
1864	122	13	84	219	1876	758	95	348	1,201
1865	134	21	118	273	1877	570	92	224	886
1866	142	33	122	297	1878	422	96	173	691
1867	172	34	98	304	First ten months 1879	299	82	144	525

TABLE No. 89.—*Death-rates.*

Annual average of three years.	Whites.	Colored.	Total.
1861-'62-'63	25.54	26.06	25.74
1876-'77-'78	53.06	42	50

Separating the Asiatics from the whites for the years 1876-'77-'78, the white death-rate was 55.65, and the death-rate of Chinese 43.66. However, the above data show that this excessive death-rate of the whites was not usual.

YELLOW FEVER.

Pezuela's statistics for the five years, 1855-'59, Table No. 47, report an annual average of 43 cases of yellow fever in the civil and 16 cases in the military hospital.

The military hospital statistics, Table No. 46, cover nineteen years, viz, the fifteen years 1851-1865, and the four years 1869-1872. No cases are reported during eight of these nineteen years, and no case until 1855, when only one case occurred. During seven other of the nineteen years the cases ranged from 1 to 10. Thus, only four of the nineteen years, 1856, 1858, 1860, and 1861, suffered at all seriously, and in the worst of these years, 1861, there were only 32 cases in 130 soldiers admitted for all diseases.

Apparently yellow fever did not begin in Sagua until the railroad, completed as alleged in 1858, approached it.

Dr. Nicolas de la Peña, medical director of the civil and military hospital, kindly forwarded the following data:

TABLE No. 90.

Years.	Civil hospital.				Military hospital.			
	All diseases.		Yellow fever.		All diseases.		Yellow fever.	
	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.
1876	832	127	22	6	2,893	187	124	86
1877	930	104	20	4	2,718	135	63	38
1878	713	92	15	6	248	11	4	3
To September 18, 1879.	461	61	0	0	108	0	0	0

Dr. de la Peña further reported that the town, its suburbs, and its sea-port were never healthier than in 1879, there being no sickness other than of chronic diseases and the usual malarial fevers, with few cases of these, although there are now 200 soldiers here in rather limited quarters.

The board of health reported that "from July to October the yellow fever prevails in every year at both Sagua and at its sea-port, Isabela; that it is endemic in these places; that there are always here a number of unacclimated persons; that the average annual temperature is 24° Reaumur (86° F.); and that frost occurred on December 24, 1856."

Mr. Swords reported: "Yellow fever has always been imported to this place from Havana. There has been no epidemic for seven years nor death of any native resident. The unacclimated number about 450, viz, 50 transient non-resident citizens, and 400 soldiers changing station. The medical officers of this port have heard of only one case of yellow fever this year, a death on board of a British brig, the Vigilant, before entering this harbor. The surrounding inland towns, Santa Clara, Santo Domingo, Cruces, and Cifuentes, are equally as liable to yellow fever as is Sagua."

On September 29, 1879, the bark Clara E. McGilvery did arrive infected with yellow fever at Philadelphia, having sailed from Sagua on September 22; but this bark had also been at Matanzas from August 19 to 22. It was reported that the shipping at Sagua was never infected. This report was sufficiently general and positive to indicate, at least, that vessels at Sagua were rarely infected.

CHAPTER LXIV.

SAN ANTONIO DE LOS BANOS.

The origin of this town in the Province of Havana can be traced to 1784. It is an inland town about 12 miles from the northern, and 15 from the southern sea-coast. It is about 20 miles southwest of Havana, and is on the railroad, opened in 1849, from Havana to Guanajay. It is on high ground, which is the watershed for both the north and south coast. The Ariguanabo river waters this locality, permeates the soil in all directions, keeps the climate very humid, and probably contributes malaria.

POPULATION AND DEATHS.

The census of 1862 states that the population of the town was 4,247, and the number of houses 961. The census of 1877 reported the population of the jurisdiction or municipality to have been 10,098. The mayor reported, through the Spanish commission, August, 1879, that the population of San Antonio and the adjacent country was about 9,000, of the town about 4,000 to 4,500, and that the annual deaths were about 300, data too indefinite for the estimation of death-rates. However, according to the official report of deaths by the mayor the death-rate would be somewhere from 33.3 to 66.6 per 1,000 population.

YELLOW FEVER.

Pezuela's statistics, Table No. 47, for the five years 1855–'59 report an annual average of 13 cases in the civil and 18 in the military hospital.

The military hospital statistics, Table No. 46, cover the twenty years 1851–1870, and report no cases during six of these twenty years. During seven other years the cases ranged from 2 to 14, and the cases were not numerous except in 1854, 1856, 1857, and 1861, '62, '63, '64. It was worse in 1854 than in any other of the twenty years.

The mayor's report states that "though fatal cases have occurred here since 1854, these have always been of Spaniards. The disease has never been as severe as in 1854. From 20 to 30 unacclimated persons are habitually here. All adjacent places are like San Antonio as to yellow fever."

CHAPTER LXV.

SAN CRISTOBAL.

This inland town is in the province of Pinar del Rio, about midway the northern and southern coast, and about 17 miles distant therefrom. It is about 50 miles southwest of Havana, and on the railroad destined for Pinar del Rio. It is reported to possess a dry, elevated, and healthy location, and to have had a population of 1,551 in 1877. No information was obtained of this place, except that reported in Pezuela's statistics, Table No. 47, which report, for the five years 1855–'59, an annual average of only 2 cases of yellow fever in the civil hospital.

CHAPTER LXVI.

SANCTI SPIRITUS.

This city, one of the oldest in Cuba, having been founded in 1514, is in the province of Santa Clara. It is about 40 miles from the northern and 20 from the southern sea-coast, and some 50 miles southeast of Villa Clara, the extreme eastern point to which the Cuban main trunk railroad line has been completed. Its sea-ports are Zaza or Sasa, located on the river Zaza, a few miles from its mouth, and navigable to the town, and Las Tunas on the southern coast. Sancti Spiritus is united to these towns, directly south of it, by a railroad about 25 miles in length from the city to the village of Las Tunas.

The information obtained of Sancti Spritus is due to the most laborious and admirable report, voluntarily presented to the American commission, by any one person. This report was signed by a veteran in the medical profession, Dr. Sebastian F. L. Cuervo y Alvarez, a graduate of Cadiz and of Madrid, who has served in both the Spanish navy and army, has received many decorations and honors from his country, and was for some years in charge of the military and civil hospital at Sancti Spiritus. The following information, except where otherwise stated, has been extracted from Dr. Cuervo's lengthy and very valuable report.

Sancti Spiritus is situated on both banks of the river Yayabo, which flows 5¼ miles to empty into the Zaza at a point about 20 miles from the sea. The sea-port is Las Tunas de Zaza. The streets of this city are generally narrow and tortuous, and the elevation is 47.5 meters, or 156 feet.

TABLE No. 91.—*Population.*

Census of—	Whites.	Asiatics.	Colored.	Total.	Number of houses.
1851	5,219	....	4,183	9,402	....
1862	7,293	....	6,045	13,338	2,092
1877	18,342	4,892	1,194	24,428	....

TABLE No. 92.—*Deaths of civilians, 10 years* 1869–1878.

Years.	Whites.	Colored.	Total.	Years.	Whites.	Colored.	Total.
1869	1,347	576	1,923	1875	714	236	950
1870	4,836	1,838	6,674	1876	715	325	1,040
1871	732	375	1,107	1877	572	277	849
1872	725	253	978	1878	658	204	862
1873	368	188	556				
1874	348	173	521	Total of 10 years	11,015	4,445	15,460

DEATH-RATES.

These were, for the annual average of the three years, 1876, '77, '78: whites, 35.33: Chinese and colored, 44.2; total population 37.54.

DISEASES.

Peznela wrote in 1866 that "the climate of Sancti Spiritus is not very healthy, because of the dampness of its soil. During the rainy season some fevers of a non-malignant type prevail."

YELLOW FEVER.

Peñuela, in 1855, quoted Dr. Cuervo to the effect that "yellow fever is present only rarely; during the past fifteen years I have only seen 8 cases, and these in recently arrived Europeans."

Pezuela's statistics for the five years 1855–'59, Table No. 47, report an annual average of 5 cases in the civil and 51 in the military hospitals. The last item is not in accord with the military hospital statistics, Table No. 46, which cover the 28 years 1851-1878. These give an annual average during the 5 years 1855-'59 of 36 instead of 51 cases of yellow fever. These statistics report no cases until 1854, no cases in six of the twenty-eight years; and in nine other years only from 1 to 18 cases. The cases were not numerous except in the years 1854, 1856, 1858, 1865, 1869. 1872, 1875-'78. Dr. Cuervo included in his report the statistics of the military hospital for the twenty-three years 1856–1878, which do not coincide with the military hospital statistics except in eight of the twenty-three years. However, both reports accord in the chief facts of interest, viz, in proving what were the years of greatest and of least prevalence. It is due to Dr. Cuervo to cite his data,* which may be compared with the table of the military hospital statistics elsewhere published.

Dr. Cuervo reported that in 1879 to October there had been in the military hospital 1,579 admissions, and of these 41 cases of yellow fever.

The following statements are also from Dr. Cuervo: "I will not decide whether yellow fever is indigenous here. The number of our unacclimated population does not exceed 50 to 100. During the past twenty-four years the disease specially prevailed in September, 1858, August, 1875, and July, 1876. It always attacks foreign-born civilians and soldiers. The disease has repeatedly attacked young Spaniards employed in commercial houses, when they had not visited any other place, whether infected or not; but such employés have always been those who had been brought in contact or close relation with packages, trunks, baggage and persons from such infected places as Havana, Cuba, Cienfuegos, &c. Such facts have been specially noted, since steamers and railroads have so greatly increased our communication with said places.

"Many native-born Cubans, habitually enjoying robust health and living in the open, pure air of the country, were compelled by the war to concentrate and shut themselves up in this city in 1870. Anxious, alarmed, destitute of resources and of means of subsistence for their families, breathing a mephitic air, and sleeping therein huddled in heaps together, surrounded by filth. they contracted pestilential diseases, so that in the nineteen months, June, 1869, to January, 1871, more than 10,000 persons died of yellow fever, cholera-morbus, Asiatic cholera, the black form of small-pox, intermittent, pernicious, and typhoid fevers, hospital gangrene, and dysentery. During this time insurgent bands surrounded and molested us day and night; we underwent a war of pillage, of surprises, and of epidemics. The deaths of 8,490 civil-

* The first figures indicate the year, the second the number of cases of all diseases admitted, and the third the number of cases of yellow fever: 1856, 515–102; 1857, 409–0: 1858, 614–119; 1859, 350–18; [illegible], 237–1; 1861, 268–7; 1862, 190–0; 1863, 183–1; 1864, 84–1; 1865, 284–73; 1866, 215-0; 1867, 171–2; 1868, 235–[illegible]; 1869, 1,515–177; 1870, 2,434–327; 1871, 5,418–34; 1872, 2,770–144; 1873, 1.201–11; 1874, 3,183–1; 1875, 6,887–440; 1876, 9,570–384; 1877, 10,553–363; 1878, 4,656–123.

ians and 506 soldiers are known and recorded, while not less than 1,150 unrecorded deaths are estimated to have occurred. In 1871 experts estimated that a population in this jurisdiction of 48,000, by the preceding census, had been reduced by death and emigration to 24,000.

"Dr. M. Canejo assures me that during this time he saw not a few native Cubans from the country suffer with yellow fever, attended with all its most marked signs and characteristics. The number so attacked he estimates at 20 to 30. But for my own part I can only say that during my forty-one years' practice of medicine in Sancti Spiritus I have never seen yellow fever in native Cubans, nor in the Chinese, nor in negroes, whether born in Africa or elsewhere.

"In none of our adjacent interior towns and villages, and especially in those elevated in the mountains, is yellow fever ever seen. This may be because such places are inhabited only by natives, Chinese, negroes, and acclimated foreigners. Banao, a village located on the side of the mountain of the same name, much higher than Sancti Spiritus, and about half way (10 miles) between this city and Las Tunas, is a remarkably healthy place, free from yellow fever, and twenty-five years ago I officially reported in its favor as a post for acclimation. However, a few years thereafter Dr. Agreda, one of my colleagues, attended a fatal case of yellow fever at Banao, and other cases have since occurred in non-acclimated persons, in transit from infected coast towns. I will not decide whether such places are free from yellow fever because of absence of the poison or because of lack of unacclimated material. Frost is unknown here, but fogs and hail do occur."

CHAPTER LXVII.

SAN JOSÉ DE LAS LAJAS.

This town, founded in 1778 or 1785, is in the province of Havana, and was personally inspected because of its general reputation for healthfulness, and for its exemption from yellow fever. It is located about 15 miles from the northern and 20 from the southern sea-coast; it is 19 miles southeast of Havana on the turnpike to Güines. This road is probably the most excellent one in Cuba, and traverses the most charming and picturesque scenery in the vicinity of Havana. There is a daily stage between Havana and San José.

The town of San José is built on a plane from 300 to 350 feet above the sea. The site is level, with slight irregular depressions, containing brooks, ponds, and swamps, all stagnant except in the rainy season. Green mud-puddles abound, as also the same unattractive houses and uncleanly people seen everywhere in Cuba. Malaria so prevails, that, while it complicates nearly every case of sickness, probably at least half of all cases are due solely and directly to this poison.

The town occupies about 170 of the 30,000 acres occupied by the municipality. Even in the town, the houses are not closely aggregated; and many of the houses are mere palm-leaf huts, with dirt floors. Visiting several of these mean huts, not one was found in which slept less than from eight to twelve persons.

Drs. Navea, Cabrera, and Bofill (the two first being members of the board of health) are the principal, if not the only, physicians in the town. To all of them much was due for cordial courtesy and intelligent aid. For the following information, thanks are especially due to Dr. Esteban de Navea, a practitioner of twenty-five years' standing, whose statements and opinions had the hearty approval of his two confréres.

POPULATION.

In 1862, the town had a population of 1,234; the present number was not reported. But the population of the municipality was, in 1877, whites 4,358, colored 1,671, total 6,029, and the total number of houses was 625.

TABLE No. 93.—*Baptisms or births in the municipality.*

Years.	White.	Colored.	Total.
1877	246	78	324
1878	268	62	330

TABLE No. 94.—*Deaths of civilians in the municipality.*

Years.	White.	Colored.	Total.
1877	92	57	149
1878	146	80	226
1879, first eight months	122	55	....

Small-pox prevailed from April, 1878, to June , 1879.

DEATH-RATES.

The annual average death-rates for the two years 1877, '78, were for the whites 27.3, for the colored 40.7, and for the total population 31.02.

YELLOW FEVER.

The unacclimated population numbers about 100, and of these 10 to 12 are annually attacked with yellow fever. The cases would be more numerous, but the unacclimated are scattered all about the country, and as the disease tends to localize itself, from year to year, in one or more of the eight districts in this municipality, all the unacclimated living in these eight districts are not equally exposed every year. Besides these annual cases of yellow fever in the unacclimated foreign-born population, Cuban children and adults, from 50 to 70 in number, suffer every year with what the people call typhus, and the doctors call "bilious remittent fever." But all three of these doctors are unanimous in declaring that this bilious remittent fever in the native born is *the very same disease* which they call yellow fever in the foreign born; that this so-called bilious remittent is characterized by all the symptoms of yellow fever, by the same tendency to localize itself in different districts and houses, and that those who have the one never have the other. They consent to call this yellow fever in Cubans bilious remittent fever, because the natives believe themselves exempt from yellow fever, and are so ignorant and prejudiced that, if told that their disease was really yellow fever, they would be dangerously alarmed. These views were entertained by Dr. Navea after a practice of twenty-five years, by Dr. Cabrera after twenty years, and by Dr. Bofill after six years' practice in Cuba.

Dr. Navea stated that the degree of annual prevalence of this Cuban "bilious remittent" varied at San José with the prevalence of yellow fever at Havana; and that it equally prevailed at Jaruco (some 12 miles northeast of San José) where he had practiced for fifteen years. No one of these three physicians doubted in the least the great liability of native Cubans, whether children or adults, to genuine yellow fever.

CHAPTER LXVIII.

SAN MIGUEL DE LOS BANOS.

This little village, a summer watering place, noted for its hot sulphur springs, is in the province of Matanzas. It is located about 20 miles southeast of Matanzas and 15 miles southwest of Cardeñas; is about 5 miles from the railroad, and occupies an elevated position between the Jacan Mountains. It is in summer much frequented by the wealthy living in the adjacent cities and country. A distinguished Cuban, Mr. Morejon, father of Dr. Abraham Morejon, who was employed in Cuba to aid the American commission, is an habitué of San Miguel, and furnished the commission with notes of ten cases of yellow fever which occurred at this elevated summer resort during the season of 1879.

The first case occurred the day after arrival from Havana via Matanzas. The other nine cases had not recently before their attacks been absent from San Miguel. Of the ten cases, seven died; all were from twenty to twenty-four years of age, and had been in Cuba from a few months to four and a half years.

The population of San Miguel in 1862 was 153, and of these 88 were whites.

CHAPTER LXIX.

SANTA CLARA OR VILLA CLARA.

This town, founded in 1664 or 1689, is in the province of Santa Clara. It is the eastern terminus of the main trunk Cuban railroad, and is distant from Havana, by

rail, 313 kilometers, or 194 miles. It is abont 25 miles distant from its northern port of entry, Sagua, and about 45 miles from Trinidad, a port of entry on the southern coast. It is situated at considerable elevation, though the surrounding country is somewhat flat. It is also reported to have broad streets, and to be well built. It is a military post of importance, and an insurrection which had broken out in this section in 1879 was probably the cause that no special reports were obtained from this place, though solicited.

Pezuela states that the dryness of its air and soil and its elevation should render it a healthy place; however, that malarial fevers and dysentery prevail as endemics.

The population in 1862 was 8,591, and in 1877 was reported to be 14,784.

YELLOW FEVER.

Peñuela reported in 1854 that yellow fever attacks few of the population; that there are some accidental cases, but no epidemics; that recruits and Europeans specially suffer, and that some years there are no cases.

Pezuela reported in his statistics for the five years 1855–'59, Table No. 47, an annual average of 23 cases in the civil and 16 cases in the military hospital. Reference to the table of the military hospital statistics, Table No. 46, will show the following facts: The twenty-eight years 1851–1878 are reported. There were no cases in twelve of these years; only from 1 to 18 cases in six other years; no cases until 1854, and no serious number until 1864. The years of special prevalence were 1864, 1868–1872, 1876, and 1877. It is noteworthy that in 1872 there were 120 cases of yellow fever in 1,585 patients admitted, while in 1875 there was not one case in 11,691 admissions.

Mr. Swords, United States consular agent at Sagua, reported in 1879 that Santa Clara was as liable as Sagua to yellow fever.

Mr. A. H. Taylor, of Havana, reported in 1879 that some years ago he had known personally seven Cubans, residents of Santa Clara, who had all been attacked by yellow fever while on a visit to Havana.

Such is a summary of all the reliable information gathered as to this central and important place.

CHAPTER LXX.

SANTA CRUZ DEL SUR.

Santa Cruz is an insignificant sea-port on the southern coast, having a population of about 1,000, is in the province of Puerto Principe, and about 45 miles south of the city of Puerto Principe. The two places are reported to be connected by a bad wagon-road, necessitating "a tedious and uncertain journey by horse or volante." It is located directly on the sea-shore, a little west of the mouth of the River Santa Cruz.

Santa Cruz is now and is reported to have been a port of entry since 1838 but it is of so little consequence that no American vessel had sailed from it during the past year. It possesses no inclosed harbor, and the open sea, which fronts it, is so shallow that a depth of 9 feet is a half mile, and of 24 feet is more than 2 miles distant from the shore.

Special reports, though solicited, were not received from this place.

YELLOW FEVER.

Pezuela's statistics for the five years 1855–'59, Table No. 47, report an annual average of 4 cases admitted to the civil and 4 to the military hospital. The latter item does not correspond with the military hospital statistics, Table No. 46, which cover twenty-seven years, viz: 1851–1867, and 1869–1878. These report, during the seventeen years 1851–1867, no cases in any of these years, except 9 in 1851, and 6 in 1859. During the total twenty-seven years there were no cases except during ten years, and the cases were not numerous except in the six years 1869–1873 and 1877.

CHAPTER LXXI.

SANTA MARIA DEL ROSARIO.

This town, founded in 1733, is in the province of Havana, and about 7 miles southeast of the harbor of Havana. No railroad connects it with Havana. Its population

in 1862 was 542. The only information obtained respecting this town is contained in Pezuela's statistics for the five years 1855–'59, Table No. 47. These statistics report an annual average during said years of 5 cases of yellow fever in the civil hospital.

CHAPTER LXXII.

SANTIAGO DE LAS VEGAS.

Santiago, founded in 1688, is in the province of Havana. It is about 13 miles south of Havana and within a mile of the southern railroad, which runs from Havana via Bejucal and Güines to Matanzas. It is situated on an elevated plateau, and is said to be very healthy. Intelligent residents of Havana reported it to have always been free from yellow fever.

POPULATION AND DEATHS.

The population in 1862 of the town was 2,837, and of the municipality 5,949. In 1877 the population of the municipality was 10,831, viz: 8,156 whites and 2,675 colored. The deaths in the municipality during the three years 1876, 1877, 1878, were 766 whites, 255 colored, 1,021 total. The resulting death-rates were 21.08 whites, 31 03 colored, and 23.54 total.

YELLOW FEVER.

Peñuela reported in 1855, "Santiago is one of the healthiest places in the island, and has escaped epidemics of cholera and of small-pox. Only occasionally does a newly-arrived Spaniard die of yellow fever."

Pezuela's statistics for the five years 1855–'59, Table No. 47, report an annual average of 15 cases in the civil and 47 in the military hospital.

The military hospital statistics, Table No. 46, cover the sixteen years 1854–1861, and 1876–1878. There were no cases in four, and only from 3 to 26 cases in six other of these sixteen years. The disease had considerable prevalence 1856–1861, and in 1876.

Through the Spanish commission an official report was received stating the above population and deaths in the municipality, and the following facts: "Yellow fever is not indigenous, but is imported to this place. In different years a few cases occur from May to October. During the past three years, September, 1876, to September, 1879, there have died every year some civilians and some soldiers, the sum total of civilians having been 8, and of soldiers 63. There are probably not more than 10 to 12 unacclimated civilians here, and these for the most part are Spaniards. Whether those who are attacked owe the disease to having visited an infected place is not known. There is nothing to prove that there is any adjacent locality where yellow fever does not exist. Unacclimated persons are wanting in localities where this disease does not occur."

CHAPTER LXXIII.

TRINIDAD.

This city, founded in 1514, is in the province of Santa Clara. It is on the southern coast, about 45 miles southeast of Cienfuegos, and among the Cuban ports of entry is the eighth in importance to American commerce. It is located 3 miles from the sea-shore, in a mountainous section, and is elevated from 180 to 360 feet above the sea, the mean altitude being 67 meters, or 220 feet.

Hazard states that the streets of this city are, with some exceptions, narrow and tortuous, and many of those on the edge of the town are unpaved; that it is situated on the side of the mountain Vijia; that it is exposed to the combined breezes of the sea and mountain; and that it is reported to be the healthiest town upon the island.

Humboldt reports that Trinidad has two ports, the harbor of Casilda and the river Guaurabo; "vessels of light draught can ascend the river to within a mile of the city, and can enter safely without a pilot. The port of Casilda is more inclosed by the land, but cannot be entered without a local pilot, because of the reefs." From the sea-port Casilda, which had in 1862 a population of 1,298, and in 1877, as is reported, 3,491, a railroad runs inland via Trinidad (6¼ kilometers, or a little less than 4 miles) to Fernandez, about 18 miles northwest.

The harbor of Casilda, *i. e.*, of Trinidad, has a wide entrance, and is about 3 miles long by 1½ miles wide; though enumerated among harbors of the "first class," Hazard

states that "the anchorage in the bay is not very good, as the water is so shallow that it necessitates the loading of vessels by lighters, unless the vessels happen to be quite small."

Trinidad is connected with all southern ports, from Batabano to Cuba, by a steamship line which plies once a week.

Valuable reports were received from Mr. G. Fischer, United States consular agent, and, through the Spanish commission, from the mayoralty, *i. e.*, probably from the board of health. These two reports are, in all particulars of importance, to the same effect, and the following facts, unless otherwise stated, have been extracted from them:

TABLE No. 95.—*Population.*

Census of—	Whites.	Colored.	Total.	Number of houses.
1827			12,543	
1841			12,768	
1846			13,222	
1862	7,003	8,652	15,655	1,570
1877	9,601	8,389	17,990	

TABLE No. 96.—*Deaths of citizens.*

Years.	White.	Colored.	Total.
1874	210	262	472
1875	233	267	500
1876	274	355	629
1877	286	258	544
1878	267	282	549

DEATH-RATES.

The above data yield, for the annual average of the three years 1876, '77, '78, the following death-rates: 28.74 for the whites, 35.52 for the colored, and 31.9 for the total population.

YELLOW FEVER.

Peñuela in 1854 enumerates yellow fever among the prevailing diseases of Trinidad.

Pezuela in his statistics for the five years 1855–'59, Table No. 47, reported an annual average of 160 cases in the civil and 58 in the military hospital.

The military hospital statistics, Table No. 46, cover the twenty-eight years 1851–1878. During five of these years there were no cases, and during five other years only one case per annum. The disease seems to have specially prevailed in 1854, 1856–1860, 1864, 1868–1872, and in 1877. In 1868 there were 113 cases of yellow fever in only 398 admissions by all diseases, while in 1875 there was only 1 case in 3,482 admissions.

The official report in 1879 from the mayoralty states that "In the military hospital there have been no cases of yellow fever in 1879 to August 25. The number of unacclimated citizens who annually come here are from 20 to 30. The physicians longest in the town, forty years, testify that during that time yellow fever has annually occurred, especially from May to November, with an occasional year of exemption. In all adjacent localities yellow fever has occurred. The white native population, engaged in agriculture and living in the interior, fled here for refuge in 1869, and a large number of them had yellow fever."

Mr. Fischer, reporting to the same effect, also stated: "It is unknown whether yellow fever is indigenous or imported to this place. The disease prevails every year, varying in its severity. In all adjacent cities and villages cases have occurred. In 1869 the disease specially prevailed among the fresh troops from Spain; and, in this same year, many of the white Cubans from the country, who had sought refuge here in large numbers, were attacked with yellow fever."

CHAPTER LXXIV.

VICTORIA DE LAS TUNAS, OR TUNAS.

This inland town, founded about 1759, is in the province of Cuba. It is about 40 miles from the northern coast at Nuevitas, and 25 miles from the southern coast, lying

between the important inland towns Puerto Principe and Holguin. Its commerce is reported to be with the harbor of Manati, which has no port of entry, and is some 35 miles to the north.

Though solicited, no special reports were received from this town.

POPULATION.

This in 1862 was 1,840, and reported to be 2,000 in 1877.

YELLOW FEVER.

Peñuela, in 1854, reported that this was one of the healthiest places in the island, as proved by the fact that, notwithstanding yellow fever had committed great ravages elsewhere and particularly in surrounding places, yet during the last three years only two deaths had occurred in the hospital of this place—one a person from Bayamo and the other from Puerto Principe. However, a military expedition which remained here six months in crowded quarters had many cases of yellow fever. The year of this occurrence is not stated.

Pezuela, in his statistics for the five years 1855–'59, Table No. 47, reported an annual average of 1 case in the civil and 2 in the military hospital.

The military hospital statistics, Table No. 46, cover the twenty-four years 1855–1878. There were no cases in thirteen, and only from 1 to 5 cases in six other of these twenty-four years. The cases were numerous only in 1869, 1871, 1872, and in 1877. In 1869 there were 178 cases in 2,221 admissions, while in 1870 there was not one case in 3,984 patients admitted for all diseases.

CHAPTER LXXV.

ZAZA, OR SAZA, OR SASA, OR TUNAS DE ZAZA, &c.

This town is in the province of Santa Clara, is on the southern coast, and is the sea-port of Sancti Spiritus, with which it is connected by a railroad about 25 miles in length. It has not only a multiplicity of names, but confusion as to these, for while some authorities designate the sea-port Zaza, or Tunas de Zaza, the railroad guide terms the sea-port "Las Tunas," and a little village some 5¼ miles north, on the Zaza River, is designated "Zaza."

This port of entry, about 25 miles southeast of Trinidad, is, after Santa Cruz, the port of least importance to American commerce. The harbor is very small, and, by the chart, so shallow that even 12 feet of water is marked outside of the harbor and more than a mile from the town.

No other information was procured of this place, except in a special report by Mr. S. R. Ballesta, United States consular agent. From this report the following statements are extracted.

"This town is 2 feet above the level of the sea. The population is 1,000, three-fourths whites. The deaths are 20 per annum. The number of the unacclimated population is about 100, besides the crews of vessels.

"Yellow fever is not indigenous, but imported to this place. The disease has never prevailed here; only a few cases are on record, and these have come from habitually infected places. The only town adjacent to this where yellow fever prevails is Sancti Spiritus. Frost has never occurred, so far as known." However, frost did no doubt occur here in 1856, as elsewhere in Cuba.

This report tends to prove that yellow fever has never prevailed at this sea-port, commercially of no importance, although it is directly on the sea-coast, and adjacent to the second largest river in Cuba.

CHAPTER LXXVI.

SUMMARY OF GENERAL CONCLUSIONS.

1.—REQUISITES TO PROGRESS IN THE KNOWLEDGE AND CONTROL OF YELLOW FEVER.

Progress in the knowledge and control of yellow fever will depend, not on some wonderful discovery by luck or genius, but on the progress of science in microscopy, chemistry and diagnostics, and in the progress of civilization, especially in the habitats of yellow fever, in vital statistics and public hygiene.

From $20,000 to $50,000 annually expended on well-directed and continuous research in places where the disease continuously prevails would now accomplish in a few years more than will be accomplished in many years by interrupted and spasmodic efforts applied to occasional epidemics, and due to the temporary panic caused thereby, and would eventually repay the United States hundreds, probably thousands, of dollars for every dollar thus expended. A people properly enlightened would demand such an expenditure for the protection of their own health and lives, as far more important than similar laudable expenditures, which are now incurred for the protection from disease of their agricultural products solely to increase their wealth. (Introduction.)

2.—COMMERCIAL IMPORTANCE OF CUBA TO THE UNITED STATES.

The United States purchases from Cuba five times more of its products than the United States sells of its own products to Cuba. The United States is the chief purchaser of Cuban products, and is an indispensable market to Cuba. Temporary suspension of intercourse during the months of chief danger from infection would tend to force the Cuban trade into the remaining months rather than seriously to diminish this trade, and the chief injury to the United States would fall upon its shipping and sailors temporarily deprived of occupation. Present sanitary restrictions on this trade very certainly do not inflict upon the United States the great losses alleged and supposed to be inflicted. (Chapter I.)

3.—SANITARY CONDITION OF THE PRINCIPAL PORTS OF CUBA.

The sanitary condition of the principal ports of Cuba is very unfavorable, as proved by these two facts: during recent years their annual deaths have ranged from 32 to 67 per 1,000 population; and in all of these ports, from which the facts could be obtained, the deaths exceed the births.

The death-rates remain unfavorable, even if all deaths by yellow fever be excluded, and at times when this disease fails to prevail; and the death-rate of the colored population, which suffers little with yellow fever, habitually exceeds the death-rate of the whites, who suffer severely. Malaria, consumption and small-pox each inflict on health and life in Cuba as much, if not more, injury than yellow fever inflicts. (Chapter II.)

4.—CAUSES OF THE INSANITARY CONDITION OF HAVANA, ETC.

The chief causes for the insanitary condition of Havana, and of Cuban towns generally, are as follows: An equable, warm, damp climate, pre-eminently favorable to vegetable decomposition, to animal putrefaction and to the growth of living organisms; the proximity of swamps, or of stagnant pools, prolific breeders of swamp poison; an inadequate supply of water, which for drinking purposes is often defective in quality and for purposes of cleanliness is always deficient in quantity; very inadequate drainage and sewerage, causing among other insanitary evils widespread subsoil and house-wall moisture; a most disgusting privy system, and an insanitary construction of houses and of streets whereby many ill-ventilated traps are provided for the warm, damp, foul confined air, favorable to the growth of disease poisons; polluted harbors, especially at Havana, constantly frequented by filthy ships; and last, but not least, an excessive density of population in certain urban localities, and generally throughout Cuba, in the houses. By such causes, the pure air indispensable to healthy life is incessantly and grossly vitiated. (Chapter V.)

5.—REMEDIES FOR THESE INSANITARY CONDITIONS.

The insanitary condition of Havana and of other Cuban towns is not due to any mysterious exceptional cause, but to an exceptional intensity of usual causes. Hence, there are no remedies for this condition other than those which are well known and which have proved successful wherever properly applied. Financial and other obstacles to the application of these remedies in Cuba are so unusually great that no hope is entertained that these obstacles will be either suddenly or soon removed. (Chapter VI.)

6.—FIRST RECORDED APPEARANCE OF YELLOW FEVER.

The pure-blooded American red Indian annually proves at Vera Cruz his present susceptibility to yellow fever; hence there is no reason to disbelieve that the aborigines of San Domingo and other Antilles were susceptible, but had, in 1492, acquired immunity from the disease by the same process and to the same general extent now

enjoyed by the white, black, and yellow or red natives of habitually infected localities in Cuba and elsewhere. Why there should have been no printed records of yellow fever until after 1492 is easily explicable, but there are no good reasons for the belief that either the origin or the first appearance among mankind of this disease occurred at the above or at any definite date.

Yellow fever may have occurred in Havana and other parts of Cuba in 1648–1655, and in Santiago de Cuba in 1745–'48, but there are no authentic records proving that the disease made its first appearance and permanent lodgment in Havana, until 1761. It certainly did not prevail severely and habitually prior to 1761. However, there are records of not less than 222 invasions of 46 other localities than Cuba during 101 of the 268 years 1494–1761; and 44 of these invasions occurred in 12 different places in the United States, from 1693, when it apparently first appeared in the United States at Boston, to 1762. (Chapters III, X, XVII, XVIII.)

7.—The so-called endemicity of yellow fever in Cuba.

Since 1761 yellow fever has prevailed, certainly in Havana, and probably in other places in Cuba, every year, and the dates of prevalence, recorded in our text-books, indicate no more than the years of severest prevalence. The disease prevails in Havana, and in some other places in Cuba, not only every year, but also every month in the year; records in 1837 indicate that, at that date, the monthly prevalence had become habitual in Havana; the statistics, solely of the military and civil hospitals, prove that during the 408 months, 1856–1879, there was only one single month free from an officially recorded case of yellow fever; and these, with other facts and the lack of any to the contrary, justify the conclusion that the monthly prevalence dates from certainly as remote a period as the early part of this century.

The degree of prevalence varies greatly in different localities. In a few towns of importance the disease made its first appearance within the memory of residents still living; in some localities it prevails but little, and in others not at all.

No localities adjacent to, and in frequent intercourse with, Havana or any other habitually infected place, were found absolutely exempt, as had been confidently reported, from yellow fever; but some such localities were found which suffer comparatively little, even certain wards of Havana enjoy this comparative exemption, and, respecting these wards, it was found that the Vedado ward was apparently as healthy and as free from yellow fever as the ward of Jesus del Monte, although the former lies low on the sea-shore, while the latter is the most elevated ward in the city; and, that the reclaimed section of the Colon ward is very sickly and much infected by yellow fever, as is also that worst of wards, Jesus Maria, although the former fronts the sea, while the latter fronts the bottom and foulest part of the harbor. (Chapters III, V, XV, XVII.)

8.—Causes of the prevalence of yellow fever in Havana and Cuba.

The appearance of yellow fever in Havana in 1761, and its subsequent annual prevalence must have been due to causes which did not exist prior to 1761, and have since been constantly present. The only decisive change, which then occurred and has since persisted, was a great and continuous increase in commerce and population; from which it resulted that the poison having been successfully transplanted where it found climatic and other local conditions requisite for its propagation, was furnished uninterrupted annual supplies of susceptible persons to feed on, and means, both ample and unrestricted, to come in contact with such persons.

The varying prevalence of the disease in different localities was found to vary chiefly with the amount of intercourse with infected places, and with the number of immigrants or other inhabitants susceptible to the disease.

The comparative exemption enjoyed by some localities adjacent to, and in constant intercourse with, infected centers, was found to be due chiefly to these five causes, viz, (1) a small number of susceptible inhabitants; (2) free exposure to the winds, thus securing better ventilation; (3) more spacious house lots, with more unoccupied space between these thus also securing better ventilation; (4) a sparse population, and (5) better drainage. In fine, wherever in Cuba there is a town which has constant intercourse with an infected place, numerous susceptible inhabitants, little exposure to the winds, and houses the most crowded together, densely inhabited and filthy, ill-ventilated and drained, there a town will be found wherein the prevalence of yellow fever is correspondingly well marked. (Chapters III, V.)

9.—Remedies for the so-called endemicity of yellow fever in Cuba.

The exceptional prevalence of yellow fever in Havana and Cuba depends on causes exceptional in quantity, but not in quality. The only remedies therefor are an exceptionally vigorous application of those found most useful elsewhere, especially

these three, viz, (1) local sanitation; (2) removal of susceptible persons; and (3) quarantine for the disinfection of infected things and for the isolation of infected persons. From quarantine nothing can be obtained except the prevention of the introduction or of the reintroduction of a disease already eradicated or under control; even if this were once accomplished, the efficient application of quarantine to any important commercial center, located in or near the tropics and having many avenues of entrance, presents so many practical difficulties that no more should be expected from it than a great diminution in the number of the risks of infection, and not the certain deliverance from all of these risks. (Chapter VI.)

10.—Protection of vessels in infected harbors.

The poison of yellow fever is not located in the water of the sea or of harbors. For the risks of infection incurred by vessels increase with their proximity to, and decrease with their distance from an infected shore or vessel; if no intercourse be held therewith the danger absolutely ceases at a very short distance, certainly within a few hundred feet from the focus of infection. Hence, the larger the harbor of an infected place, and the greater the distance at which vessels anchor from the shore and from each other, the less dangerous is the harbor. Among the harbors of all places habitually infected, the harbor of Havana is exceptionally dangerous, because exceptionally small, and the only means by which this harbor, irrespective of its infected shore, could be rendered as little dangerous as are other harbors, would be to deepen its shoal places, and otherwise so to enlarge it that every vessel which entered therein could be anchored, and would be forced to anchor, at safe distance from the shore and from other vessels. Since those vessels which now anchor in this harbor as far as is practicable from the shore (and in this harbor it is impossible to anchor, more than 1,500 feet from the shore), rarely become infected, very much less frequently than those moored at wharves, it is concluded that the putrid emanations from the water in this harbor, to which emanations special infective power has been attributed, have no such power, but that the true sources of danger are located on the land and on infected vessels.

For the protection of vessels in the harbors of infected places, it is, then, extremely important that they should anchor at safe distance from the shore and from infected vessels; and if the distance be necessarily too little for safety, it is important that healthy vessels should be kept to the windward of infected foci. Vessels should be frequently and thoroughly cleansed, ventilated, and, by every other possible means, disinfected. The introduction of fomites should be prohibited as far as may be practicable. Persons on board, especially those susceptible to the disease, should abstain from intercourse with the shore and with infected vessels, and those who are sick with yellow fever, or with suspected yellow fever, should be neither retained nor received on board; for while yellow fever is not personally contagious it is communicable, and, as long as the modes by which it is communicated remain undetermined, prudence demands that all possible modes shall be controlled.

Apart from the special danger attached to articles which, and to persons who, have been subjected to specially infected surroundings, those fomites are probably the most dangerous which are the most porous, or which have the most interstices whereby air is confined. The determination of what things are specially yellow-fever fomities, and to what comparative extent, is most important to commerce, and deserves careful research. Since ballast is very porous and absorptive it should be regarded as suspicious, and therefore treated as dangerous when either procured at, or exposed to, infected localities. The depots for ballast at Havana (and especially the one among these at Regla) and the depots at Matanzas and Cardenas are very unfavorably located.

The various sanitary measures, indispensable for the protection of vessels, cannot be executed without efficient laws and efficient sanitary officers. Those laws which must be enforced on foreign soil, or on foreign vessels, cannot be efficiently executed without foreign consent; hence an international sanitary code is necessary to confer on nations all powers requisite to protect each other from communicable diseases. (Chapters VII, IX.)

11.—Portability and communicability of yellow fever.

Like typhoid fever and cholera yellow fever is not inoculable and is not personally contagious, as are small-pox, measles, &c., but all three of these diseases are portable and communicable. However, the fact that the modes by which typhoid fever and cholera may be communicated have been better determined in recent years than has yet been the case with yellow fever, causes the communicability of the last to be still as much doubted as was formerly doubted the communicability of typhoid fever and of cholera.

The arrival of things or persons from an infected place has not been proved to have immediately preceded the first appearance of yellow fever in all cases, nor its reap-

pearance in many, doubtless in the majority of cases; but this sequence has been conclusively proved in numerous cases, especially in instances of the first appearance of the disease. The disproportion between the unproved instances or negative evidence, and the proved instances or positive evidence, has decreased with an increase of the best methods, men, and opportunities to secure proofs; so that the instances in which the transmission of the disease has been successfully traced, especially in navies and armies, have now become very numerous. While only one conclusively proved instance of importation is required to establish the fact that yellow fever can be imported, yet, apart from this, the great number, and the progressive increase in the number of instances in which it has now been established that outbreaks of yellow fever have immediately followed and have been otherwise closely connected with the arrival of things and persons from infected places, justify the deduction, "*post hoc propter hoc.*" Combining these facts with the marked preference of the disease to routes of travel, and especially to places where ships, steamboats, and railroad cars halt, the conclusion cannot be avoided, that whatever may be its origin, whether it can or cannot originate spontaneously and locally, yellow fever is portable, can spread from a nucleus of infection, and therefore can be communicated.

Places which are populous and have many avenues of entrance furnish much less favorable opportunities to determine whether a disease, habitually prevalent in such places, can be imported, than are furnished by places which are little populous, have but one or few avenues of entrance, and suffer with the disease only rarely and at distant intervals. Notwithstanding this fact, medical opinion in Cuba, based on experience there, now strongly preponderates in favor of the belief that yellow fever is a portable and communicable disease. Personal intercourse, in 1879, with many of the most distinguished physicians in Cuba, encountered no one of these opposed to this belief, and assurance was given by these that *all* physicians of eminence in Cuba were advocates of this belief. None the less many of these physicians did believe that, although the disease could be imported, it was indigenous to or originated spontaneously in certain Cuban localities. Thus, since some "indigenists" are at the same time importationists, the total separation of the former from the latter fails to represent fully the numerical superiority of the importationists; however, no other classification is derivable from the official written reports to the United States Commission. From 19 of the 49 places specially reported, there were received from boards of health, medical officers, and consuls 22 official reports, wherein an opinion is expressed whether yellow fever, at each one of these 19 places is "indigenous" or "imported." Of these 22 reports, 7 pronouncethe disease indigenous, 10 pronounce it imported, 4 consider it doubtful, and one, from the board of health at the seaport, Bahia Honda, testifies that yellow fever does not exist there; hence is neither indigenous nor imported. Excluding this last report, there were of the 22 reports, 15 others from boards of health; and, of these, 7 pronounce the disease indigenous, 7 imported, and one doubtful. Further criticism of these reports discloses the fact, that the places where yellow fever is most prevalent furnish the more numerous reports of supposed indigenous origin, while the places where the disease least prevails furnish more numerous reports of supposed origin by importation. (Chapters VIII and XXVI to LXXVI.)

12.—Disseminating causes.

Ships, steamboats, and railroad cars are the chief disseminators of the poison of yellow fever, which is thereby disseminated with a facility apparently the same whether against or with prevailing winds. The harbor of every infected place constantly and conclusively proves that winds fail to infect vessels even at a short distance from the shore, and other facts also demonstrate that the poison is distributed by winds to distances so limited that the "epidemic-wave theory" of yellow fever, provided an aerial wave is signified, becomes absurd.

Experience fails to teach that those are in special danger who are exposed to winds prevailing from an infected focus quite near at hand; but experience does teach that confined air, that is, air undisturbed by winds, is most favorable to the poison; that those who live or sleep nearest the ground, where air is least disturbed by winds, are exposed to greatest danger, a danger which decreases with elevation; and that those engaged in ambulatory are more exposed than those engaged in sedentary occupations, thus showing the tendency of the poison to become localized in scattered foci, and not to be generally distributed by the winds, or to be diffused like a gas. (Chapters VIII, IX, X.)

13.—Causes, alleged but not real, for either the generation or for specially the propagation of the poison of yellow fever.

Neither the sea-shore nor salt water, nor mixed salt and fresh water, originate or specially favor the growth of the poison of yellow fever. Sea-ports at the mouths of rivers, and sea-ports generally, have hitherto suffered most frequently, because of (1)

their greater intercourse with infected places; (2) their frequentation by ships, the best carriers of the poison, and (3) their larger proportion of susceptible inhabitants—immigrants, visitor, sailors, and soldiers. Yellow fever is neither generated nor propagated any better in Cuban localities on the sea-shore, than in those located inland; for it does not prevail in the former more than in the latter, except when the sea-ports have a greater amount of intercourse with infected places, and a greater number of susceptible inhabitants. Yellow fever is not, as is usually believed, exceptionally severe in the shipping of infected ports, except when the number of susceptible sailors is in exceptionally large proportion to the susceptible inhabitants on land. In Havana it is not sailors but soldiers who suffer with exceptional severity, and chiefly because there is a larger number of the susceptible among them than in any other class.

An inadequate supply of water certainly does not generate nor does it apparently favor the growth specially of the poison of yellow fever. There was no yellow fever in Havana during the time when the water supply was the worst; though this supply was improved in 1835, and again in 1878, no abatement of the disease followed; Vera Cruz, though abundantly supplied since 1867, suffers as before; and experience at New Orleans and other cities is to the same effect, respecting the introduction of an ample supply of water, which, however, it must be noted, is rarely, if ever, adequately used.

Cemeteries within city limits certainly do not generate and apparently do not favor the growth, specially, of the poison of yellow fever. Since 1871 all the dead of Havana have been buried too distant from this city to exercise an influence on disease, yet there has been no abatement in yellow fever.

There is convincing evidence that the preservation, and, probably, the growth of the poison of yellow fever are favored by places containing warm, damp, foul, confined air, such places as the holds of ships, trunks, ill-constructed barracks, and therefore probably privies and sinks, but there is no such evidence that fæcal or urinary excretions, even from those infected, have any special influence on this disease.

There is no evidence justifying the belief that the peculiar geology or physical geography of places have any special influence on yellow fever. The influence of the latitude of places is due to the temperature, and the favorable influence of altitude above the sea is due to diminished temperature, to better exposure to winds, and to the habitually sparse population and restricted intercourse of mountain localities. The favorable influence of altitude has been much exaggerated, since yellow fever has certainly twice visited Newcastle, Jamaica, 4,200 feet above the sea, and is alleged to have visited not less than five places in the Peruvian Andes, over 10,000 feet high, one of these attaining an altitude of 14,000 feet. Naturally the altitude attainable would decrease from the equator. (Chapters III, IV, X, XII, XIII.)

14.—Causes which do not generate, but do, either certainly or probably, favor the growth of the poison of yellow fever.

Climate has a decisive influence on yellow fever, but not even the climate of places where the disease most prevails can generate the poison, as is illustrated by the facts, among many others, that Havana escaped until 1761, and that the disease fails, to this day, to occur at places within a few miles of, and, therefore, possessing the same climate as the chief habitats of the disease. While climate has a decisive influence on the propagation of the poison, yet no proofs have ever been presented that the wind from any particular quarter, that pressure of air, electricity, magnetism, or ozone have anything special to do with this influence. Only one climatic factor, temperature, is certainly, and only one other, humidity, is probably indispensable to the growth of this poison, and there is little reason to believe that there is ever, in any part of the yellow-fever region, a lack of as much moisture as the poison probably does require.

Although a temperature above the freezing point is indispensable to the growth of the poison, yet the degree and duration of the heat requisite vary widely within certain limits, which are frequently misapprehended, as shown by the following facts: Though cases of yellow fever have been present, yet the disease has frequently failed to spread in the very habitats of the disease, not only when the heat was unusually great and prolonged, but also when the humidity was abundant, when numerous susceptible persons were present, and when the insanitary evils were as unfavorable as usual; hence, one or more other conditions are necessary to the growth of the poison besides unusual heat, even when conjoined with the presence of humidity, susceptible persons, and insanitary evils. Again, frost does not occur in Cuba, yet yellow fever habitually declines in September and October, at the very time when the number of susceptible inhabitants habitually increases, and when both humidity and insanitary evils remain unchanged; hence the usual decline, in tropical countries, is not due to frost, nor to absence of any conditions known to be requisite. Further, while yellow fever does habitually decline in September and October, none the less there has not infrequently occurred in Cuba recrudescence in the winter, and in more northern places a prevalence of the disease during months colder than Cuban winters ever are; hence, the usual decline

cannot be attributed to lack of the amount of heat indispensable to the growth of the poison. These facts seem inexplicable except by the hypothesis that the poison of yellow fever has, as most living organisms have, a limited period of each year for reproduction, but that, when subjected to unknown exceptional conditions, the poison may produce a double crop, as also occurs with some organisms. Within as without the tropics the poison manifests an annual tendency to become dormant, and an occasional tendency even in summer and under apparently favorable conditions, to die out, as occurred in Cuba in 1866, thus annually presenting favorable opportunities to control it, and encouraging the hope that it might be eradicated from even its tropical strongholds.

Whether any special combination or particular recurrence (other than just stated) of climatic factors influence yellow fever is not now known, nor likely to be known, until further progress has been made in science and civilization; for little hope is felt that the study of meteorology in connection with yellow fever will add anything to present knowledge, until accurate records are kept, not only of all cases as well as deaths, but also of all disturbing influences, other than climate, such as the daily varying number of the susceptible who may be exposed.

All except two of the insanitary evils, elsewhere detailed as the causes of the insanitary condition of Havana, existed there in equal, probably in greater degree, long prior to the appearance and continued prevalence of yellow fever; hence these insanitary evils, including all varieties of decomposition, putrefaction, defective ventilation, and filth, combined with favorable climatic influences, cannot generate yellow fever. The two evils, above excepted, because these have increased, are density of population and therewith a continuous increase in the number of susceptible inhabitants; but dense aggregations of susceptible persons, subjected to all of the previous insanitary evils, have occurred repeatedly in the American and constantly in the Asiatic tropics without generating yellow fever; hence all of these conditions when combined account for the origin of the poison no better than they would account for the origin of the house-wall molds, of the maggots, and of the house flies which have, like yellow-fever, also increased in Havana. However, it is not doubted that susceptible persons are indispensable for the growth of the poison, and their close aggregation is admitted by all to be a favoring condition—a significant fact, since density of population is favorable specially to communicable diseases.

While no condition and no combination of conditions, which have been cited, account for the origin of yellow fever, neither are there any ever suggested by man's imagination which do account for it any better than his imagination once preposterously accounted for the origin of numerous vegetables and animals, as due to a spontaneous power inherent in special local conditions. Proof that yellow fever has been transplanted in many instances justifies the belief, with our present knowledge of communicable disease poisons, that it has been transplanted in all instances of its first appearance; and if the absolutely first origin of this poison be conceded, as with living organisms, to have once occurred, there remains no more difficulty in accounting for its accidental transplantations, its propagation, and its variable crops, than in accounting for these same things respecting numerous vegetables and animals. Hence it is concluded that the origin of yellow fever is no more within reach of scientific research than is the origin of living organisms, and that the true field for research, designed to control the poison, is to determine the conditions requisite for its propagation.

Respecting these conditions, it is now known that heat, humidity, susceptible persons, density of population, confined air, defective ventilation, inadequate drainage, and filth with all this implies—conditions, all of which are variable—are among those which are either necessary or favorable to the growth of the poison, and that there are other unknown conditions which are indispensable. These indispensable unknown conditions may be of such nature as the continuous uniform heat necessary to hatch an egg, or as subjection of the poison for a certain time to darkness, to an excess of carbonic acid, or to such other like conditions as are now known to be indispensable to the growth of some microscopic organism.

The failures, under apparently the most favorable conditions, to transplant the poison constantly recur, and are more frequent than are even the numerous successful transplantations, thereby proving that a combination of all required conditions occurs comparatively rarely, and thereby justifying again the hope that yellow fever will, with increasing knowledge, eventually become a readily controllable disease. (Chapters IV, V, VIII, XI.)

15.—Origin and nature of the poison of yellow fever.

This poison spreads, multiplies, and is endowed with the function of reproduction, which is limited to living organisms. Microscopical evidence that this poison is a living organism is no more necessary to such a conclusion than microscopical or chemical evidence is necessary to prove the conclusion that this poison is a dead, inorganic, miasmatic, or other mysterious something. Since each theory lacks con-

clusive proof, the one which the better explains all the phenomena of the disease is the more rational. The former has become the more rational, because, among other reasons, many microscopic living organisms have been discovered, which cause specific spreading diseases in vegetables and animals, while neither microscopy nor chemistry have yet demonstrated the supposed inorganic or dead organic poisons which cause any such diseases; and because well known microscopic living organisms are endowed with characteristics, which best explain the characteristics of the poisons of yellow fever and of other specific spreading diseases.

The belief that the poison of yellow fever is an inorganic dead something, and therefore that it originates spontaneously and locally is due to two causes, viz, the absence in numerous instances, of proof of importation, and disbelief in the duration of the dormant vitality of the poison. Absence of proof is mere negative evidence, and instances thereof, however numerous, do not counterbalance one single instance of positive evidence, which would alone suffice to prove that the poison can be imported; and a sufficient number of such instances have now been secured to justify the inference that the poison has been imported in every instance where it did not preexist. Whether the poison, in cases where certainly not imported, and certainty on such a subject is most difficult to acquire, did or did not pre-exist, depends on whether it was ever before present; and, if so, what was the possible duration of its dormant vitality. While research and careful reports of all cases respecting the possible duration of the dormant vitality of yellow-fever poison are much needed, yet there is good evidence that it may lie dormant even two years. In any case the power of specific spreading-disease poisons, yellow-fever included, to resist the destructive influence of time and of other deteriorating agents, and to lie dormant, without manifesting their presence until conditions arise favorable to their action and growth, is well established, while the power of any of these poisons to develop spontaneously remains unproved. Advancing knowledge has constantly tended so to strengthen faith in the one power, which has been conclusively proved, and so to destroy faith in the other, which finds at the present day less reason for acceptance than ever before, that credence is now justifiable in the least credible instances of dormant vitality, in preferance to credence in the most credible instances of supposed spontaneous origin. (Chapter VIII.)*

16.—Origin of yellow fever on ships.

The doctrine of the spontaneous origin of yellow fever on ships is theoretically incredible, and is practically destitute of proof derivable from a solitary instance of the infection of any vessel, which had not previously communicated, directly or indirectly, with some infected place, thing, or person. This doctrine is due to ignorance respecting the duration of the dormant vitality of the yellow-fever poison, and to hasty credence in the negative evidence that an infected vessel had not previously communicated with any source of infection. In the vast majority of cases, this negative evidence has been to the effect that the infected vessel had visited some usual habitat of the poison, which, however, was not present, as is alleged, at the time when visited by the vessel. Experience, in any place habitually infected by yellow fever, abundantly teaches that easy credence should never be given evidence to the effect that the disease has ceased to prevail, or has failed to reappear at the usual season, unless this evidence is derived from the highest sanitary officer in the place; and that even this evidence should not be trusted, unless it be known that said officer is not only trustworthy and competent, but also is provided with ample opportunities to know whereof he testifies.

In fine, although yellow fever never has originated on ships, yet this disease continued, throughout the long period of time during which ships were the chief vehicles of transportation from infected places, to be, in a certain sense, a "seaport," "nautical," and "oceanic" disease; but, with the invention of steamboats, it, in the same sense, became a disease of towns on navigable streams, and with the invention of railroads, it became a disease of inland railroad depots. Hence, though ships, for obvious reasons, continue to be the best carriers of yellow fever, this is no more a "seaport" or "oceanic" disease than it is a fluvial, riparian, or inland disease, and no more a ship disease than it is a steamboat and a railroad disease.

A careful study of the fomites and modes by which vessels become infected is calculated to advance existing knowledge on this subject generally, more than a like study prosecuted elsewhere. (Chapter IX.)

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*Since correcting the proof-sheets of Chapter VIII, the record of the following instances of dormant vitality has been observed and may, in this place, be added to those instances cited in said chapter.

Pasteur (pp. 83, 169, 172, "Studies on Fermentation," London ed., 1879), reports that "alcoholic ferment," that is, yeast germs, "may be dried at the ordinary temperature of the atmosphere and preserved in *the form of dust* for a period of *seven months and longer*, without losing its faculty of reproduction." Further, that these same germs may have their dormant vitality aroused to reproductive life, after "*even several years*," provided that they have been subjected to certain specific conditions for the purpose of thus prolonging their dormant vitality.

Tyndall ("Floating Matter of the Air," London ed. 1881) reports, p. 109, that some germs, thoroughly desicated, preserve their dormant vitality after *eight hours boiling*. He further cites, on p. 21, from Dr. De Mussey, two marked instances of the dormant vitality of the poison of scarlet fever; in one instance for six months, and in the other for "*more than a year and a half*."

17.—ACQUISITION OF IMMUNITY FROM YELLOW FEVER, OR ACCLIMATIZATION SO-CALLED.

The better comprehension of this subject is indispensible to progress in our knowledge of yellow fever, and especially of its diagnosis, a subject of primary importance to the sanitarian.

Natives of Cuba, as of all other countries, of every age, sex, and race, are liable to yellow fever; and only those who have had the disease, or have constantly resided in infected localities, enjoy immunity. The fact that the natives of every place never apparently suffer at all, while susceptible foreigners usually do, is conclusive evidence that the poison is present in said place, that the natives have been habitually subjected thereto, and have, because of the habitual presence of the poison, acquired immunity through some process or other.

While physiological functions can become accommodated to different seasons and climates—to this extent acclimatizing vegetables, animals, and man—yet there is no good reason to believe that any climate can render any living thing insusceptible to any poison. There is even less reason to believe that the direct influence of climate can render man insusceptible of the poison of yellow fever; hence to designate his acquisition of immunity from this disease, "*acclimatization*," is a gross abuse of language.

It has been urged that the immunity enjoyed by the natives of habitually infected places might be due to their better-developed excretory powers; but it is impossible to accept this explanation, when it is considered that the adult natives of non-infected localities, within a few miles of infected localities, do not, while the adult natives of the latter do enjoy immunity; and that foreign-born children do not, while all native born children do, as is alleged, enjoy immunity. It is incredible that a comparison between these two classes would demonstrate a difference of excretory function, and it is also incredible that every native child should be able to take a dose of yellow fever poison fatal to a foreign adult, and because of superior excretory power, experience, as is alleged, no effects whatever.

It is not known that the law of the "survival of the fittest" may not be applicable to yellow fever, possibly to the extent that parents who were never, or perhaps very little susceptible, might beget descendants who, in the first or in succeeding generations, would be insusceptible. But there is good evidence that parents do not, after they have had yellow fever, beget, outside of habitually infected places, children who are insusceptible to the poison; and it is certain that foreign-born parents, who have had yellow fever, do not, for this cause, beget native-born children, who, in the very first generation, are insusceptible to and endowed, as is alleged, with immunity from this disease. In fine, the wholesale immunity which, it is alleged, is enjoyed by all children born in habitually infected places cannot be due to inheritance.

Administration of, or habituation to, any known poison, other than yellow fever, does not destroy susceptibility to the latter.

Habituation to the poison of yellow fever itself cannot be the process by which the native children of infected places acquire—without any disturbance, as is alleged, of health—their apparent insusceptibility; for, in such case, it would be necessary to admit, of this poison, that which is not true of any other known poison, and is otherwise incredible, that even a brief habituation confers generally a permanent insusceptibility, and that doses violently poisonous to most foreign-born adults produce no ill-effects whatever on any native-born children.

One attack of a non-recurring disease is the only general process, admitted for all non-recurring diseases except yellow fever, by which future immunity can be acquired, and, among various supposed processes, this remains the only one which is undisputed for yellow fever. Although it is denied that this process applies to children born in infected places, none the less it is certainly true as to New Orleans, and therefore probably true as to all other places, that whenever yellow fever kills the adults, then, during the very same time, the children under ten years of age die in unusual number. Hence, this excessive mortality of children must be due either to the poison of yellow fever or to some one or more other disease poisons which are invariably associated with the yellow fever poison; and, since no such poisons are known or are suspected to exist, the conclusion is justifiable that the same poison which kills the adults also kills the children. It therefore follows that the insusceptibility to yellow fever, alleged to be enjoyed by the natives of habitually infected localities is apparent, not real, and that there immunity, *en masse*, is acquired by the same process that the foreign-born acquire it, which is also the same process by which immunity is acquired in every other non-recurring disease.

The vital statistics of New Orleans prove that children under two years, and especially those under one year, are, as in several other zymotic diseases, comparatively little liable to yellow fever, while those from to five years and older suffer severely.

Experience in every yellow fever habitat has proved that some adults and many children suffer, especially during epidemics, with febrile attacks which protect from yellow fever, and yet are accompanied by symptons too mild and vague to justify, in our present ignorance, a satisfactory diagnosis. The special study of such cases is

indispensable to the removal of our unanimously admitted deficiencies in the diagnosis of yellow fever. (Chapter X.)

18.—YELLOW AND MALARIAL FEVER.

The old theory, still entertained by a few, that yellow fever was due to an intensified malarial poison, is now so untenable that those who are well informed do not require even this brief allusion to guard them from the misapprehension that silence on this subject implies assent to such a theory.

That both poisons are living organisms, which require for their growth some conditions which are the same, is most probable; but the characteristics which prove them to be two distinct specific poisons are fully as well marked as are those characteristics which distinguish typhoid from typhus fever.

APPENDIX C.

REPORT ON ORGANIC MATTER IN THE AIR.

By PROF. IRA REMSEN.

At the request of the National Board of Health, I undertook, about a year ago, an investigation on the best method for the detection and determination of the nature of the organic matter which is well known to exist in the air. I was perfectly conscious, at the outset, that very grave difficulties would be encountered in the course of such an investigation, and it seemed to me somewhat doubtful whether much of value could be established without the expenditure of a vast amount of labor much more than was contemplated by the board or by myself. After due consideration, however, I began the work in the hope that, though the results reached might not be quite satisfactory something more than is at present known might be learned concerning the subject under examination. Its importance seemed to warrant the attempt. The work has been prosecuted, with some brief necessary interruptions, throughout the academic year, and I herewith have the honor to submit to the Board a report on the results reached. A preliminary report, giving an outline of the work, and not including any details in regard to the methods employed, has already been presented to the Board, and published in the "National Board of Health Bulletin" for January 31, 1880. The present report will include, not only the details of the experiments referred so briefly, in the published statements, but also of additional experiments, performed since the time of the first writing, with the object of more fully establishing the correctness of the conclusions first drawn, or of gaining new light upon the subject under investigation.

While I cannot claim to have added very much to the subject, I think it will be seen that greater exactness has been introduced in the methods of investigation than heretofore, and that the future possibilities are brought out more clearly. A firm basis for future work has been gained; some facts of permanent value have certainly been established; and, if the solution of the problem has not been reached, some, if not most, of the blame should be attributed to the nature of the problem itself. The work requires the greatest amount of patience and the greatest amount of skill. Without a combination of these two qualities the results reached would be of no value. It has been my good fortune to have associated with me, at successive periods of the investigation, two gentlemen excellently qualified for the work, both thoroughly trained chemists, both conscientious, and gifted to an unusual extent with patience. I here desire to acknowledge my obligations to Mr. W. Mager and Mr. T. W. Day, who have acted as my assistants, and to whose zeal and industry much of what has been accomplished is due.

INTRODUCTION.

"Pure air" and "impure air" are expressions which carry with them but vague meaning. Air may, of course, be rendered impure in a great variety of ways, and produce upon those who breathe it an equal variety of effects. The most frequent kind of contamination of air is that which results from bad ventilation of apartments which are occupied by living beings, and every one has experienced to a greater or less extent the effects of this kind of contamination. For a long time it was thought that the bad effects produced by such air were due to the abnormal quantity of carbonic acid or carbon dioxide introduced by the breathing process, and this gas has been regarded as one of the most common enemies of mankind. Books have been written on the subject, and the popular mind is still thoroughly imbued with the idea that carbonic acid is the injurious constituent of the air of badly ventilated apartments. Many medical books, and even some which are specially devoted to chemistry, still serve to spread this idea. But it has been conclusively shown that carbonic acid may be intro-

duced into air, otherwise pure, to a much greater extent than is commonly introduced by the breathing process, even under the most adverse conditions of ventilation, without producing the characteristic effects of impure air, or indeed any disagreeable effects whatever. And Pettenkoffer has shown that the really injurious constituents are in all probability the refuse organic matters which are given off from the body, together with carbonic acid. These are in a condition of decomposition, and, if taken back into the system again, it is natural that there should be a more or less serious disturbance of the vital phenomena.

In order, then, to form an estimate of the purity or impurity of air, we ought to be able to determine the amount of the really injurious constituents present in it, *i. e.*, of the organic matters. It is well known, however, that the method usually employed for the purpose of testing the purity of the air consists in determining the amount of carbonic acid present. If the impurities are introduced by the breathing process the latter method is certainly of value, for it may be assumed that the proportion between the amounts of organic matter and of carbonic acid given off from the body is pretty constant; and hence, if we know the amount of carbonic acid present, we can draw a conclusion with reference to the amount of the organic matter, or rather with reference to impurity of the air.

Still there are circumstances under which the determination of the amount of carbonic acid in air would fail to give the information we desire, and, even under ordinary circumstances, it would be better if it were possible to determine directly the amount of the injurious constituents. It is believed, for instance, and apparently with justice, that the air of our dwellings and of other buildings is, in some way, very frequently contaminated by the gases arising from imperfect sinks and water-closets. It would plainly be impossible to determine the extent of the impurity thus introduced by the same method as is used for air contaminated by the process of respiration. For this purpose we need a method which shall enable us to determine directly the amount of the organic matter, and every one will at once recognize the importance of having such a method at our command. This need has been felt for some time, and attempts have been made to supply it, though these have not been very successful. It is not proposed to give here a *complete* historical sketch of the attempts that have been made from time to time, but the principal ones demand attention.

HISTORICAL SKETCH.

One of the first serious investigations on the subject under discussion which requires consideration here was undertaken by Dr. R. Angus Smith. His results are embodied in papers which appeared in the *Journal of the Chemical Society*, vol. xi, p. 217, *Chemical News*, 1870, and in a work entitled "*Air and Rain*" (London, 1872). Smith first endeavored to collect the organic matter by passing the air through water. In regard to this he says: "If air be passed through water a certain amount of this material (the organic matter) is obtained, but I have found it difficult to pass a sufficient quantity through. If it is made to pass rapidly, *absorption does not take place*, and evaporation of the water is the consequence; if it passes slowly, it requires several weeks to pass a hundred cubic feet through a small quantity of water. I continued the experiment for three months, but although I obtained sulphuric acid, chlorine, and a substance resembling impure albumin, I did not get enough to make a complete examination, and, indeed, this could not be expected, as I found that in that time less than one hundred gallons had passed through."

Finding this method of collecting impracticable, the author later describes another in these words:

"A bottle of the capacity of about 2,000 cubic centimeters, or nearly two quarts, was filled with the air to be washed. This was done by means of a pump of the capacity of about a tenth of a cubic foot of a flexible material.

"The tube from the flexible pump in a closed state is put into the bottle, the mouth being left open, so far as the tube permits it. The pump is then drawn open, and the fresh air rushes into the bottle. The bottle contains 30 to 50 c. c. of the purest water. This is shaken with the air. Of course the tube is previously drawn out and the glass stopper put on. It is very important that the water should be pure. * * * Patience is not lost in excessively careful preparations for experiments of this kind. * * * By experiment Smith found that one stroke with the pump, whose volume is twice as large as the volume of the bottle, is sufficient to refill the bottle. For determinations of the organic matter he fills it with bad air ten times; with good air *a hundred*, and in some cases even *a thousand times.*"

This latter method certainly calls for a great amount of patience. Its tediousness is almost sufficient to exclude its use as a practical measure. It is not stated in Smith's papers whether the air that had been shaken with water was subsequently examined for organic matter or not; and it is questionable whether complete absorption can be effected in this way. From subsequent statements made by Smith it seems clear that if the air be drawn through a number of vessels and tubes for the purpose of securing

complete absorption a considerable quantity of the substances which it is desired to obtain remains in contact with the walls of the glass vessels and tubes.

At first Smith confined himself to the action of the air under examination on a dilute solution of potassium permanganate. He noticed very marked differences in the effect produced upon the solution by air of different degrees of purity, and showed that, in general, the purer the air the less reducing action does it exert upon the permanganate. The presence of nitrous acid and sulphurous acid, in city air especially, interferes very decidedly with the value of the permanganate test, and, though Smith is at first enthusiastic in regard to this test, he afterwards practically abandons it, preferring to determine only the nitrogenous material in the water after the absorption of the organic matter.

In 1872 Moss published (*Lancet*, p. 627) a paper "On the Estimation of Nitrogenous Organic Matter in Air." He passed the air through wash bottles containing pure water, and then examined the solutions thus obtained according to the usual method for determining the amounts of free and potential ammonia.

In view of Smith's remarks on the use of wash-bottles, Moss's own description of his experiments would appear to condemn them as of little value, and it is, at least, surprising to learn that "in the whole of the experiments the quantity of air passed through the aspirator is corrected for temperature to 0° c., and for pressure to 30 in. barometer. Very little that is new is added to our knowledge of the subject by Moss's experiments, but they seem to indicate marked variations in the amounts of nitrogenous matter present in the air under different circumstances, and, in this respect, they confirm the results of Smith. The external air at Portsmouth contained, according to Moss, in a cubic meter an amount of combined nitrogen varying from 0.072 miligram to 0.274 miligram, while air taken from a hospital ward contained 1.542 miligrams, and that from a men's privy 1.133 miligrams in a cubic meter.

The sanitary department of Glasgow, under the direction of Dr. James B. Russell, medical officer of health, has for some time past published monthly reports on the air of the city. These reports are prepared by the chemist of the department—first, E. M. Dixon, B. Sc., and at present William J. Dunnachie. Mr. Dixon devised a method for extracting the objectionable constituents from the air, which may be described in a few words: The air is drawn through three glass vessels, called absorbers, "about 7 inches long and 2 inches diameter, each of which is fitted with an India rubber cork having two perforations for the insertion of glass tubes." Through one of these perforations in each cork a tube passes nearly to the bottom of the absorbers and there terminates in a flattened bulb around the outer edge of which a row of minute holes is drilled by a lapidary, The absorbers are connected by glass tubes which pass through the second opening of each cork. "To the last of the series of bent tubes an India rubber pipe is attached, which communicates with the 'inlet' of an ordinary gas-meter, registering from 0.01 to 1,000 cubic feet. The outlet of this meter opens into a cylindrical receiver, with which all the other meters of the station in a like manner communicate. A ½-inch lead pipe passes from the receiver, and is attached to the aspirator, which is in connection with the water main."

One series of the absorbers is used for the ammonia and albuminoid ammonia. In order to effect complete washing of the air a measured quantity of perfectly clean glass beads is placed into each glass, and the "rose," or perforated end of the glass tube, placed in position among the beads. "Each set of 'absorbers' is kept out twice for a period of forty-eight hours and once for one of seventy-two hours in each week. When returned, the tubes and absorbers are disconnected in rotation, emptied and thoroughly washed with distilled water."

The work done at Glasgow seems to be rather more systematic, and entitled to correspondingly more weight, than that done at most other places. It seems, however, justifiable to object to the use of a series of vessels such as is there employed. Smith's experiments prove that the use of complicated vessels, of which a considerable amount of surface is exposed, is fatal to accuracy and, although the errors in the Glasgow experiments must be very nearly constant, it is highly desirable to find a method involving simpler vessels.

At the observatory of Montsouris, near Paris, elaborate examinations of air are made, as well as at Glasgow. The method of washing the air is similar to that employed at Glasgow, though it appears, in some respects, to be somewhat less perfect. One modification deserves mention. The piece of the apparatus which corresponds to the "rose" of the Glasgow apparatus above described is made of platinum. Determinations are made of the ammonia and albuminoid ammonia.

It will thus be seen that the subject under discussion has seriously claimed the attention of those interested in the problems of sanitary science, and a great deal of time has been spent upon it.

NEW EXPERIMENTS ON COLLECTING ORGANIC MATTER FROM THE AIR.

In beginning actual work it was first considered necessary to devise a more perfect method for the collection of the nitrogenous organic matter than had yet been de-

scribed. A suggestion made by Chapman (*Chemical News*, 1870, p. 65) was taken advantage of, and, with the aid of some modifications, a very satisfactory and simple method was perfected after considerable work. Chapman used finely-powdered pumice-stone placed on a layer of coarser pumice-stone on wire gauze in a funnel. The material was first heated to redness and, before the air was drawn through, it was moistened with a little water. He says that he found this method satisfactory, though I have been unable to find a description of any experiments which furnish proof of its accuracy.

It seemed desirable to diminish, as much as possible, the surface of the absorbing material directly exposed to the air, and to increase the thickness of the mass through which the air was to be passed, so Chapman's apparatus was modified by using, instead of the funnel, a tube of three-eighths inch internal diameter, and from 5 to 7 inches long. This was drawn out at the lower end, so as to accommodate a small piece of rubber tubing, and in this form it is ready for use. After being carefully washed, it is filled with ignited pumice-stone. Experiments were at once undertaken to test the efficiency of the apparatus, and, as these yielded very satisfactory results, it may be best to describe here in detail the method of work.

Preparation of the reagents.—As in all the experiments which form the basis of this report the object primarily sought for is the determination of very minute quantities of material, it is above all necessary at the outset to procure absolutely pure reagents, or, at least, to determine with the greatest accuracy the amount of impurity in the reagents used.

1. The *water* was carefully distilled, and then steam was passed through this for some time. Water thus prepared did not give the slightest evidence of the presence of ammonia when treated with Nessler's solution. If, however, 500 c. c. of this water were distilled through a carefully cleaned condenser, the first 100 c. c. of the distillate gave a slight test for ammonia. It might be thought that this ammonia came from the walls of the glass condenser or the connections, but this is apparently not so. For, if the distillation of a given specimen be continued until the distillate ceases to give the ammonia test, and a fresh specimen of the purified water be then distilled immediately through the same condenser, the first portions of the distillate give the same test as in the first instance. It seems indeed almost, if not quite, impossible to get water absolutely free from ammonia. This fact need not, however, interfere with the accuracy of subsequent determinations, for it is easy to determine the amount of ammonia which is given off from the purified water, and then to subtract this amount from the total found in the experiment. This was done in every case. Of course a considerable quantity of water may be purified at one time and kept carefully protected from the air for future use. If a determination of the amount of ammonia given off from 500 c. c. of this water is made, then it will be known how great a correction must be made in determinations made with this water.

2. The *standard ammonia solution* was prepared from pure ammonium chloride. The salt was purified by sublimation and finally by re-crystallization. 3.147 grams were dissolved in a liter of water (purified as above), and 50 c. c. of this concentrated solution were then diluted to one liter, so that one c. c. of the dilute solution corresponded to 0.00005 gram NH_3. This solution was used throughout the experiments.

3. A *solution of caustic potassa* was made by dissolving 400 grams of stick caustic potassa (Merck's, purified by alcohol) in water, and diluting the whole to one liter, so that 1 c. c. contained 0.4 gram KO,H. This solution was boiled for some time to drive off any ammonia contained in it.

4. A *solution of sodium carbonate* was prepared by dissolving 500 grams of the pure crystallized salt, $Na_2CO_3+10H_2O$, in water, and diluting to one liter, then boiling as before to drive off any ammonia present. 1 c. c. of this solution contains 0.5 gram $Na_2CO_3+10H_2O$.

5. A *solution of potassium permanganate* was prepared by dissolving 8 grams of $KMnO_4$ in water, and diluting to one liter, then boiling as before. 1 c. c. contains 0.008 gram $KMnO_4$.

6. The *pumice-stone* used in the absorbers was prepared by coarsely powdering the ordinary material, then sifting to get rid of the fine powder, then bottling that portion which consisted of pieces about the size of duck shot. The fine powder is objectionable on account of the bumping which it is pretty sure to cause when brought into water and distilled. The material as described is capable of absorbing nitrogenous matter from the air, as thoroughly as finer powder. Before each experiment the pumice-stone to be used should be heated to redness in a platinum crucible for some time. When filled into the carefully cleansed absorbing tubes the mass should be moistened with a little water.

In addition to the materials described above, a Nessler's solution is, of course, necessary for the estimation of the ammonia. This is prepared according to the ordinary directions.

Method of experimenting.—In order to make the determinations of the amounts of free and albuminoid ammonia obtainable from the organic matter of the air, the air to

be examined is first drawn through the pumice-stone absorber by means of an appropriate aspirator. The volume of air necessary for a determination varies, of course, according to the amount of impurity. Usually from 50 to 100 liters were drawn through. After the absorption is completed, the pumice-stone is brought into a flask perfectly cleaned with the purest water and 500 c. c. of the same water and 5 c. c. of the sodium carbonate solution added. Connection is made with a clean condenser, and 100 c. c. distilled off (distillate A) and put aside in an appropriate vessel for treatment with Nessler's solution. A small amount of the distillate may be collected beyond this point and tested for ammonia, but it will usually be found to contain none.

Twenty c. c. of the potassium hydroxide solution and 50 c. c. of the permanganate solution are added to the contents of the flask, another 100 c. c. distilled off, and the distillate (distillate B) put aside.

Distillate A is now Nesslerized, and, after the necessary correction is made, the amount of ammonia found represents the *free ammonia*. Distillate B in like manner gives the *albuminoid* ammonia in the volume of air drawn through the absorbers. The results may then be made comparable with others by calculating for a given volume of air. The quantity of ammonia derived from the organic matter is usually stated *in millgrams in a cubic meter* of air, or *in grams in a thousand cubic meters*. The quantities given in this paper are according to the latter standard.

Unless special precautions are taken, great inconvenience, if not the destruction of the glass vessel used in the distillation, is caused by bumping. This can be prevented almost entirely by heating the flask quite slowly before beginning the distillation, and not allowing the flask to cool during the process of distillation. The solutions of potassium hydroxide and of the permanganate should also be hot when added.

If all the directions above given are carefully followed, no difficulty is experienced in making the estimations; though it will be seen that the great number of precautions necessary make the work very tedious.

Experiments to determine the efficiency of the pumice-stone tube.—The absorber having been prepared as above described, air was drawn through it, and then through four wash-bottles. Ninety-one and five-tenths liters of air were drawn through in the first experiment. In each of the wash-bottles there were 50 c. c. water, and in the first one there were further 5 c. c. dilute hydrochloric acid. The time occupied in drawing the air through in this experiment was ten hours. On now bringing the pumice-stone in water and distilling as above described with the necessary reagents for the purpose of determining the entire quantity of ammonia obtainable from the collected material, an amount corresponding to about 0.3 gram in 1,000 cubic meters of air was found. On examining the wash water contained in the four flasks, only the quantity of ammonia known to be present originally was found. Then the air was passed successively through two pumice-stone tubes, and, while the first yielded a considerable quantity of ammonia, the second did not yield even a trace. After this, air drawn through a vessel containing decaying meat was used, the experiments otherwise being exactly like those just described. Three pairs of parallel experiments were performed and these gave the quantities of ammonia stated below, calculated for 1,000 cubic meters of air:

Series.	First experiment.	Second experiment.
	Gram.	*Gram.*
A	0.457	0.45
B	0.608	0.527
C	1.092	1.158

The wash water in the three flasks used in each experiment was now examined, and again only the original quantity of ammonia was found. It is thus shown conclusively that the pumice-stone tube is an efficient absorber of the nitrogenous organic matter contained in the air. As regards the rapidity with which the air is drawn through the absorber, it seems to make very little difference what the rate is. A number of experiments were performed to test this. The rate of passage was varied between ten liters in two hours and the same amount in forty-five minutes. In all cases, however, no ammonia was obtained from absorbents placed between the first pumice-stone tube and the aspirator.

The *absorber* employed in these experiments can then, I think, be recommended as the best thus far used. It is simpler than that introduced by Dixon at Glasgow, or that used at Montsouris, and, at the same time, while accomplishing everything which is expected of the two forms mentioned, it is free from what appears to me to be a very serious objection to these, viz, the exposure of a considerable glass surface to the action of the air under examination. The new absorber is shown to collect all the nitrogen-

ous matter, and there is no reason to doubt that the pumice-stone gives up all the nitrogen again when distilled with the proper reagents. The unqualified recommendation of the apparatus which I am able to give is founded upon a very large number of experiments which need not be described individually here. One was but a repetition of those which preceded it, with the exception of some minor modifications, and, as the figures actually obtained furnish but little proof of the accuracy of the work, they may be omitted.

Parallel experiments to determine the reliability of the results.—Having shown that the nitrogenous matter can be completely absorbed by the pumice-stone, the next question to be answered was, whether the results obtained can be depended upon? Will the method employed always give the same results when applied under the same circumstances? As far as I can learn from the literature of the subject, very little, if any, effort has thus far been made by experimenters in this field to determine the reliability of the different methods employed. As the air in any place is likely to undergo change from day to day, it is plain that the only way to test any given method fairly is to *examine at the same time specimens of the same air*, so that parallel experiments were always carried on. Sometimes, indeed, three experiments with the same air were carried on at the same time for the purpose of more thorough verification.

At first the total amount of ammonia was determined, and afterwards determinations of the free and albuminoid ammonia were made. Here I shall confine myself to the first experiments. In all cases the amounts stated correspond to 1,000 cubic meters of air.

External air, taken from a height of about 25 feet above the ground, was drawn by means of aspirators in the usual manner through pumice-stone tubes.

Series.	First experiment.	Second experiment.	Third experiment.
	Gram.	*Gram.*	*Gram.*
A	0.343	0.361	0.439
B	0.457	0.45	....
C	0.608	0.527	....
D	1.092	1.153	....

A number of other experiments were performed of the same kind as those above considered, and these yielded practically the same results; that is to say, the agreement between the results obtained in parallel experiments was in no case poorer than that observed above. If we remember what extremely small quantities of matter we are here dealing with, the agreement must be regarded as fairly satisfactory, so that the method may without doubt be used with advantage whenever it is desired to obtain information in regard to the total amount of nitrogenous or ammoniacal matter contained in the air.

Are all organic matters retained by the pumice-stone?—While the pumice-stone absorber enables us to collect and estimate the amount of nitrogenous matter in the air, the question remains open whether there are not other organic matters not containing nitrogen which may pass through the absorber. To test this point, contaminated air was drawn through pumice-stone and then through a flask containing a very weak solution of potassium permanganate. If organic matter passes through the absorber the effect ought to be shown upon the permanganate solution. The result of the experiments in this direction was to show conclusively that something passes through the absorber which exerts a reducing action upon the permanganate, and previous experiments have shown that this is not nitrogenous. The entire unreliability of the permanganate method for determining the quantity of organic matter present prevented the making of any quantitative experiments, but some experiments were performed for the purpose of discovering approximately the proportion existing between the non-nitrogenous oxidizable material and the nitrogenous. Air from the same source was passed at the same time: 1st, through pumice-stone and a weak solution of permanganate; and, 2d, through a permanganate solution alone of the same amount and same strength as in the first experiment. The amount of air which was freed from nitrogenous material by the pumice-stone required to decolorize the permanganate solution was then noted, and the amount of air not passed through pumice-stone required to accomplish the same result. The results reached in these experiments were not satisfactory, but they showed that, as would naturally be expected, the air from which the nitrogenous material had not been removed contained more oxidizable material than that which had been passed through the pumice-stone. They throw no light whatever upon the important question, whether the non-nitrogenous oxidizable material is injurious or not; and until this question is answered, it will be impossible to say how much weight should be attached to determinations of the nitrogenous constituents as a means of judging of the purity of the air. It is undoubtedly true that

at present we possess no method that can give more than a faint intimation of the presence of non-nitrogenous organic matter in the air, and if these could be shown to be injurious we should be in a sorry plight indeed, so far as our power to determine the amount of impurity is concerned.

Reliability of the results obtained in determining ammonia and albuminoid ammonia.—After the collection of the material from the air, the problem of its examination becomes very similar to that of the examination of the organic matter in water. It is known that great differences of opinion exist among those who have worked on the latter problem, and it can safely be said that up to the present no satisfactory conclusion has been reached. It is not necessary to enter into the discussion as to the relative merits of the different methods which are in use or which have been recommended for the determination of organic matter in the air. It is plain that it is not of so much importance to sanitarians to know the total amount of organic matter, that is, matter containing carbon, in the air, as to the amount of those particular organic matters which are most likely to be injurious. These are commonly supposed to be nitrogenous, on the assumption that they are derived from animal substances which nearly always contain nitrogen.

The *albuminoid ammonia* process, as developed by Wanklyn, Chapman, and Smith (*Journal Chem. Society*, N. S., vol. v, p. 591; Wanklyn, *Water Analysis*, fourth edition, p. 25), has attracted a great deal of attention, and has been extensively used. As is well known, this process depends upon the fact that many nitrogenous organic substances give up their nitrogen in the form of ammonia when treated with potassium hydroxide and permanganate. If we then have a mixture of substances consisting, on the one hand, of ammonia or volatile ammoniacal bases (ethylamine, methylamine, &c.), and, on the other hand, of various nitrogenous organic substances containing nitrogen in different forms of combination, we can distinguish between the two kinds of substances. The original mixture is treated with sodium carbonate and water, and the ammonia given off under these circumstances is classed as *free ammonia*. On then treating the residue with potassium hydroxide and permanganate a new portion of ammonia is given off. This is classed as *potential* or *albuminoid ammonia*.

I will here call attention to experiments undertaken to decide whether this method gives concordant results when applied to the examination of the material collected from the air in the pumice-stone absorber. A large number of parallel experiments was performed for this purpose. The results of some of the typical are here communicated.

First series. (Laboratory air.)

		Gram.
1st experiment—	Free ammonia	0.37
	Albuminoid ammonia	0.28
2d experiment—	Free ammonia	0.36
	Albuminoid ammonia	0.36

Second series. (Air through decaying meal.)

1st experiment—	Albuminoid ammonia	0.45
2d experiment—	Albuminoid ammonia	0.50

Third series. (External air.)

1st experiment—	Free ammonia	0.120
	Albuminoid ammonia	0.345
2d experiment—	Free ammonia	0.073
	Albumionoid ammonia	0.457

Fourth series. (External air.)

1st experiment—	Free ammonia	0.428
	Albuminoid ammonia	0.215
2d experiment—	Free ammonia	0.120
	Albuminoid ammonia	0.241
3d experiment—	Free ammonia	0.157
	Albuminoid ammonia	0.292

Fifth series. (External air.)

1st experiment—	Free ammonia	0.067
	Albuminoid ammonia	0.093
2d experiment—	Free ammonia	0.064
	Albuminoid ammonia	0.14
3d experiment—	Free ammonia	0.07
	Albuminoid ammonia	0.08

Sixth series. (External air.)

		Gram.
1st experiment—	Free ammonia	0.103
	Albuminoid ammonia	0.051
2d experiment—	Free ammonia	0.09
	Albuminoid ammonia	0.05
3d experiment—	Free ammonia	0.074
	Albuminoid ammonia	0.041

Seventh series. (Air contaminated by breathing.)

1st experiment—	Free ammonia	0.287
	Albuminoid ammonia	0.339
2d experiment—	Free ammonia	0.220
	Albuminoid ammonia	0.309

Eighth series. (Laboratory air.)

1st experiment—	Free ammomia	0.0793
	Albuminoid ammonia	0.449
2d experiment—	Free ammonia	0.075
	Albuminoid ammonia	0.42

Ninth series. (Laboratory air.)

1st experiment—	Albuminoid ammonia	0.22
2d experiment—	Albuminoid ammonia	0.195

The results recorded above will, I think, serve to give a fair idea of the accuracy of the method involved; and it will be seen from them that, in determinations of the organic matter made in one and the same specimen of air, there is liability of considerable variations, due, as it seems, to the imperfection of the method. The results obtained, then, cannot be regarded as accurate or anything like accurate, but, at the same time, the method is capable of showing changes in the amount of nitrogenous organic matter when these are considerable. The difference between ordinary impure air and pure air can easily be detected, but slight variations, such as may take place from day to day, of a fairly pure atmosphere, can hardly be determined with any degree of confidence.

Variations produced in the amount of nitrogenous organic matter in air by different causes.—After having succeeded by long continued labor in getting a satisfactory method for the determination of the ammonia and albuminoid ammonia obtainable from the nitrogenous organic matter of the air, the next step in the inquiry was the examination of air purposely contaminated by different causes. I regret that the amount of time necessarily spent on the first part of the problem, *i. e.*, the devising and testing of the method, was so great as to leave very little for a study of its applications to practical cases. But it may be said that the whole subject is now in such condition that these applications can be made comparatively readily, and at the close of this report suggestions will be made with reference to the study of the air by the perfected methods.

1. *Decaying meat* was first employed as a means of contamination. Meat in active decomposition, and giving off an unendurable odor, was placed in a bottle with a little water, and air drawn through this bottle in such a way as to cause *constant bubbling of the water*. Special precautions were taken to secure complete absorption, but it was found that at least all the *nitrogenous material* was absorbed by one pumice-stone absorber. The air freed from nitrogenous material still possessed a very disagreeable odor, and would certainly be instinctively avoided by any civilized human being. Several experiments of this kind were performed and always with the same result, *i. e.*, there was not found an excess of albuminoid ammonia over that ordinarily found in the open air. The amounts in some cases were indeed less than is frequently found in external air.

Now this unexpected result may be interpreted in two ways. If we assume that the air which was passed through the bottle with the decayed meat was unfit for breathing purposes, and we can hardly avoid this assumption if we take the horrible odor into consideration, then, as no excess of albuminoid ammonia was found, the conclusion would naturally follow that the amount of albuminoid ammonia found in air is not a measure of the organic impurities, a conclusion which is plainly of the very highest importance in this connection.

Again, if we assume that albuminoid ammonia *is* a measure of the organic impurities of the air, then it would follow that the organic matter is effectually retained by the water.

In a paper read before the Philosophical Society of Glasgow, February 18, 1880, Dr. Neil Carmichael briefly discusses the question here suggested. The subject of the paper is, "The trap and water-closet system, and the relations of the same to sewage products, gaseous and other." He refers to some air analyses published in the reports on the air of Glasgow by the sanitary department, and finds that air a few feet over the Clyde, under the Broomielaw bridge, is rather more free of impurities than the air taken from the city, that is, it contains less organic matter. Still the water of the Clyde at the same point, on being analyzed, was found to contain 0.263 grains free ammonia and 0.065 grains albuminoid ammonia per gallon, representing a very large amount of organic impurity. He then says: "The organic particles are rendered so heavy by soaking with water that they are not raised with the aqueous vapor, or by wind blowing over the surface. Marshes and swamps, in a dry season, when the water is low and the particles are drying on the muddy sides and on the vegetation on the banks, are frequently highly pestilential. Mr. Baldwin Latham, in his work on *sanitary engineering*, on this point says: 'One thing is certain with reference to malaria, that all authorities are agreed that it is never extricated from a water surface.' These methods of answering the question are, however, not quite conclusive, although they doubtless show a high probability in favor of the opinion expressed. I therefore set myself, by direct experiment, to determine the point." The author's method consisted in drawing contaminated air through water and then studying the effects of this air upon various liquids capable of nourishing germs. His conclusion is that germs do not pass through the water. With reference to water-traps he says: "They exclude the soil-pipe atmosphere to such an extent that what escapes through the water is so little in amount, and so purified by filtration, as to be perfectly harmless."

Dr. Carmichael regards my experiments with air contaminated with decayed meat, described briefly in the preliminary report published in the "National Board of Health Bulletin" for January 31, 1880, as confirming the conclusion that water retains the organic matter from air passed through it. This, however, is only true if we assume that albuminoid ammonia is a measure of the organic impurities. There still remains the suggestive odor of the air after it has passed through the water, to be explained. Is this air, in spite of its odor, harmless? Special experiments would be required to answer this question.

Within a very short time Werniche (*Virchow's Archiv.*, 79, 424) has published an elaborate paper on the air as a transporter of germs, and in this he shows that bacteria are not taken up from a putrefying liquid or moist slime, but when there are bubbles in the liquid which break and throw up a spray the air becomes contaminated.

2. Air was next contaminated by means of meat which was allowed to pass to the last stages of decomposition and gradually become dry. The experiments with this air were carried far enough to show that it yields a considerable larger amount of ammonia and albuminoid ammonia than ordinary air, and the conclusion may be drawn that "malaria" if, as is supposed, it arises from dried matter, will probably be found to yield an abnormally large quantity of albuminoid ammonia. Experiments upon this point are, however, entirely wanting up to the present.

3. Finally, air contaminated by the process of respiration was examined. For this purpose an air-tight box, about three feet long by two feet high and two broad, was prepared and into this was placed a good-sized dog. Air was then drawn slowly through this box and examined as usual. Two determinations are here given. These were made at the same time.

		Gram.
1st experiment—	Free ammonia	0.287
	Albuminoid ammonia	0.339
2d experiment—	Free ammonia	0.220
	Albuminoid ammonia	0.309

The amount of ammonia and of albumoid ammonia found are somewhat larger than the amount found in the external air at about the same time, though not as great as were found in some experiments with external air at other times.

Two dogs were then placed in a box and the air examined in the same way. No perceptible change was noticed in the composition of this air compared with that contaminated by the presence of one dog in the chamber.

In this connection it should be remarked that Smith made use of the permanganate test to examine air contaminated by the breathing process, and noticed an increase of oxidizable material in such air. But he did not observe a difference when two persons were placed in the lead chamber (which corresponded to the dog-box used in the experiments described above) and when there were three. In regard to this point he says: "The cause may be that only a limited quantity is kept in suspension in the air, the rest being deposited."

Apparently the most remarkable results yet reached in the analysis of air are those recently described by W. Van Slooten (*Journal American Chemical Society*, I, 263), who undertook to determine the *free albuminoid ammonia* in the air of New Orleans during

a part of the year 1878, covering the period of the yellow fever epidemic. He found: "First, that the air was abnormally charged with albuminoid ammonia during the epidemic; second, that the abnormality disappeared with the fever; third, that the atmosphere not in immediate connection the ground was with comparatively free from any abnormal variations from an average standard." It would be venturesome to accept these results without verification. The figures given by Van Slooten are certainly in accordance with the view that, at the time of the epidemic, the air is abnormally charged with albuminoid ammonia. This may be true, and, nevertheless, it may be that no direct connection exists between the epidemic and the albuminoid ammonia. Conclusions like that of Van Slooten can only be of value when it has been shown that during an epidemic there is more albuminoid ammonia in the air than there is at the same period of other years when epidemics are not raging. It should further be said that the description of Van Slooten's experiment is not calculated to inspire confidence in the results, and until further evidence of the accuracy of the work is furnished, not much weight can be attached to his statements.

Ammonia and albuminoid ammonia as measures of the impurity of the air.—From what was said above, it will be seen that the question whether the amounts of ammonia and albuminoid ammonia yielded by air can be regarded as reliable measures of the impurity of the air is still an open one. Up to the present the nitrogenous materials have been regarded as the really injurious ones, and an increase in the quantity of the two forms of ammonia has been sufficient to condemn the air yielding it. In Dr. Smith's works it is constantly assumed that the substances yielding ammonia are the injurious ones, and so, too, it is common to regard the analogous substances found in water as the objectionable ones. In a recent work by C. B. Fox the same idea is upheld. He says: "Ammonia, which in itself is harmless, is a product of animal organic matter, and is present in air in exceedingly variable quantity, outof which it is washed by the great air cleanser, rain." Again he distinctly says that the ammonia in the air is "derived from decomposing animal matter, such as manure, sewage, effete matter from the lungs and skin of men and other animals."

In the discussion of the results reached in the air analyses of Glasgow and Montsouris, above referred to, Dr. James B. Russell calls special attention to the fact that the analyses show in general *that there is an increase of ammonia and albuminoid ammonia in the winter months.* The Parisian and Glasgow results both agree in this respect. Accepting this as a general truth, it is plain that the source of the nitrogenous matter cannot be mainly decaying organic matter. If the latter were the source, the largest amounts of the two ammonias should be found in the summer months. Dr. Russell unhesitatingly accepts the view that a comparatively prolific source of the nitrogenous matter is the combustion of coal, which would of course account for the increase noticed in the winter months. This gives rise to new difficulties; for the question is in each result, how much of this nitrogen is derived from decomposition and how much from combustion?

The simple statement of fact that a given sample of air yields an abnormally large quantity of albuminoid ammonia is not sufficient to enable us to draw a conclusion with reference to the purity of the air. We must know at what season of the year the air was collected, and whether in the city or country; in fact, we should know everything possible concerning the air, and then let the conclusion finally drawn be a resultant of all the facts. It is probable, however, from what is now known, that the determination of the amount of albuminoid ammonia yielded by air may, under many circumstances, furnish us with important information concerning the quality of the air, but great caution is necessary in dealing with this principle of examination.

GENERAL CONCLUSIONS.

In looking back over the field traversed, I cannot avoid a feeling of dissatisfaction. A great deal of time has been spent in this investigation. Constant attention to minute details has been necessary, and at times disappointment has followed disappointment. Here and there, however, light has been thrown upon the subject; and whatever its future development may be, I think the facts established here will always stand. Let us, then, pass quickly in review the main results:

1. The nitrogenous matter of the air may be thoroughly collected by means of the pumice-stone absorber described in this report.

2. The total amounts of ammonia found in experiments performed at the same time with the same specimens of air agree fairly well with one another; so much so as to warrant the use of the method for the examination of the air.

3. When free and albuminoid ammonia are determined, the results obtained do not always agree very closely, but still the agreement is sufficient to enable the experimenter to detect such variations as are likely to occur between pure and impure air.

4. Air contaminated by being drawn through water containing decaying meat does not yield more than the usual quantity of albuminoid ammonia.

5. Air contaminated by being drawn over comparatively dry decaying organic matter yields more than the usual quantity of albuminoid ammonia.

6. Air contaminated by respiration yields more than the usual quantity of albuminoid ammonia.

7. It is necessary in judging of the purity of air to take all the facts known in regard to it into consideration. The simple determination of any one constituent can never be a sufficient basis for the formation of a competent judgment.

8. It would be useless to have examinations of air made by any but the most careful workers. It would be time thrown away to have such analyses made by the average practical chemist.

Finally, as to suggestions for the future. A number of questions have been left unanswered in this investigation. A very important one is this: Is the air which has been deprived of its nitrogenous matter also deprived of its injurious constituents? If this is ever to be answered, it is evident that it cannot be by chemical methods. The effect of the air on fermentable liquids must be studied, and also on animals. Can an animal continue to breathe normally in such air?

A second question which ought to be answered is this: Does the amount of organic matter in the air vary with different conditions of the air, as, for instance, with the hygrometric state? This can only be answered by a long-continued, systematic series of examinations of the air, such as are at present being made at Glasgow, Montsouris, and at some places in Germany. It may be said, however, that, up to the present, no connection has been observed between the amount of organic matter and other conditions of the air.

Again, it would be interesting to determine how much nitrogenous organic matter from ordinary contaminating sources can be held in suspension in the air.

Many other questions suggest themselves, but those given above indicate that an almost unlimited field opens before us, and show clearly that the only way in which results of great value can be reached is by united effort. A single individual can do little more than point out the way in which results may be reached, and clear the road for advances. It will only be when health departments in a great many places are impressed with the importance of such subtle examinations as those of the air, and provide the means for making them through long periods, that our knowledge will be materially increased on the subject treated in this report. When records, made year after year by competent men using the best methods, are in our possession, then, probably, conclusions of great importance for sanitary science will be drawn.

IRA REMSEN.

APPENDIX D.

REPORT UPON DISINFECTANTS.

By GEORGE M. STERNBERG, *Surgeon, U. S. A.*

EXPERIMENTS DESIGNED TO TEST THE VALUE OF CERTAIN GASEOUS AND VOLATILE DISINFECTANTS.

The following experiments, designed to test the value of some of the most commonly used disinfectants, were commenced by the writer in 1876. They are now resumed by direction of the National Board of Health, and the results will be reported from time to time:

When disinfection is practiced in ships, dwellings, and hospitals, for the purpose of destroying the virus of some infectious disease, other measures are commonly resorted to as well, such as ventilating, scrubbing, whitewashing, and painting, so that the result, if successful so far as the non-occurrence of subsequent cases of the disease is concerned, cannot fairly be attributed to the action of the disinfection employed; and it is difficult to determine what share, if any, the so-called disinfectant has had in the accomplishment of this result. It is well known to sanitarians that methods of disinfection have often enjoyed the confidence of the public, and even of accomplished physicians, which are demonstrably inefficient, and consequently harmful, as giving false confidence and supplanting other and really efficient methods. As examples of this may be mentioned the chlorine saucers which it was formerly the fashion to place under the beds in hospital wards and the piece of flannel saturated with a few drams of carbolic acid, which is still frequently hung up in the sick-room by order of the "doctor." No one will deny that chlorine and carbolic acid are, under certain circumstances and in certain quantity, valuable disinfectants. The protest made here is against their use in demonstrably insufficient quantity, with the unjustifiable assumption on the part of physicians and their patients that disinfection has been practiced, and that responsi-

bility as to the occurrence of subsequent cases of the disease is at an end after such disinfection.

It is evident, then, that those disinfectants which enjoy the most reputation should be tested by some method other than their use in the sick-room, and that, if possible, exact data should be obtained to serve as a guide in their employment.

The main difficulty in such an undertaking is to obtain a test which will be accepted as satisfactory. The power to destroy the vitality of bacteria is a test of value, as indicating the arrest of putrefactive processes, but, in the present state of science, cannot be accepted as proving a power to destroy the specific poisons of the infectious diseases. It has been used in some of the following experiments and will be used in future for a comparison of results with those obtained from other tests believed to be more trustworthy. These tests depend upon the power of the disinfecting agent to destroy the potency of vaccine virus as shown by vaccination, and of the septic poison as shown by inocculation experiments.

It may probably be safely assumed that the infectious material of small-pox would be destroyed, so far as its specific action upon man is concerned, by any substance which is capable of neutralizing the potency of vaccine virus, if it be subjected to the action of the particular disinfectant used under the same conditions as to temperature, moisture, quantity of disinfectant, amount and physical condition of virus (wet or dry, in powder or in masses, &c.). The inference may not be justified that what destroys the infectious material of small-pox will destroy the specific poison of the other infectious diseases, but there is at least a strong probability in its favor and no better test can perhaps be found.

The apparatus used in the following experiments is a simple air-chamber, having a capacity of 646 cubic inches, 18.62 pints, or 10.58 liters, and intended to represent the apartment to be disinfected. This air-chamber is provided with a close-fitting door, to permit the introduction of the vaccine virus, &c.; and has openings, closed by corks, for the introduction of gases. The top and sides are of glass, and the glass top has a perforation closed by a valve upon the inside of the box, but operated from the outside.

This is for the purpose of permitting experiments upon bacteria, &c., without opening the air-chamber, into which a given percentage of some disinfectant has been introduced. To accomplish this a watch-glass containing a drop of the fluid to be experimented upon (*e. g.*, putrefying meat-juice filled with bacteria) is inverted over this opening and the valve is opened, thus exposing the concave surface of the watch-glass to the atmosphere of the interior of the box. A microscope, mounted upon the air-chamber as a stand, permits the observation of bacteria upon the inverted watch-glass while exposed to the disinfectant.

Experiment 1.—Drop of water containing actively moving bacteria exposed over aperture in top of air-chamber, on inverted watch-glass; one sulphur match burned in air-chamber; all movements of bacteria had ceased at end of five minutes; watch-glass removed from over aperture; no movement four hours later.

Experiment 2.—A similar drop exposed for two minutes. All movement had ceased at expiration of this time; a few bacteria moving at the end of four hours.

Experiment 3.—A similar drop exposed for one minute. Bacteria still active; four hours later still active. Exposed again for four minutes to SO_2 produced by burning half a match (split) in air-chamber; all motion had ceased at expiration of this time.

Experiment 4.—A similar drop exposed to SO_2, produced by burning one grain sulphur in air-chamber; all motion arrested in one minute.

Experiment 5.—The same, burning one-eighth grain sulphur in air-chamber; all motion arrested in six minutes.

Experiment 6.—Drop of infusion of meat containing innumerable active bacteria (*b. termo*) exposed on inverted watch-glass over aperture in air-chamber; one-fourth grain of sulphur burned; motion ceased in eight minutes.

Experiment 7.—The same repeated, burning one grain of sulphur in air-chamber. Motion ceased in two minutes. Experiments 8 and 9, same repeated with same result.

Experiment 10.—The same, with one-half grain sulphur burned in air-chamber. Motion ceased in two minutes.

Experiment 11.—The same, with same result.

Experiment 12.—One fluid dram of pure carbolic acid in watch-glass placed on floor of air-chamber. Drop of fluid containing bacteria exposed on inverted watch-glass over aperture. Bacteria still active at end of twenty minutes.

Experiment 13.—Drop of vegetable infusion containing bacteria exposed to fumes of carbolic acid from a rag suspended in air-chamber. Amount used, eight drops impure acid. Motion ceased in twenty minutes.

Experiment 14.—One drop of pure carbolic acid placed within one-eighth of an inch of drop of water containing bacteria in watch-glass, which was inverted on glass top of air-chamber (aperture closed). Motion of bacteria ceased in five minutes.

Experiment 15.—Liquor ammoniæ in watch-glass placed on floor of air-chamber. Drop of water containing bacteria exposed over aperture. All movement ceased in three minutes.

Experiment 16.—Bacteria in drop of putrefying meat infusion exposed over aperture, with one ounce chloride of lime in saucer on floor of air-chamber. Bacteria still active at end of thirty minutes.

Experiment 17.—Watch-glass filled with infusion of meat swarming with bacteria of putrefaction placed in air-chamber, the watch-glass resting upon one ounce of chloride of lime in a saucer. Bacteria still active at end of thirty minutes. At end of one hour movement sluggish. In one hour and thirty minutes all movement had ceased.

Experiment 18.—Above repeated with same result.

Experiment 19.—Drop containing bacteria exposed to fumes of five drops of impure carbolic acid from rag suspended in air-chamber; equal to forty-six fluid ounces in a room twelve feet square and twelve high. Movement ceased at end of one hour.

Experiment 20.—Above repeated. Motion ceased at end of thirty minutes. (Smaller drop and more time allowed for volatilization of carbolic acid.)

Experiment 21.—Above experiment repeated with same result; motion ceased in about thirty minutes.

Experiment 22.—Experiment repeated with three drops of impure acid; motion ceased in one hour and ten minutes.

Experiment 23.—Vaccine virus, quite fresh, rubbed up with glycerine and divided into two portions: one portion exposed for twelve hours to SO_2, produced by burning one-fourth grain of sulphur in air-chamber; three children vaccinated on the following day with this virus, also with the virus not exposed to sulphurous acid gas. *Result:* Examined children on seventh day, and found in each case a characteristic vesicle from the insertion of virus not exposed to SO_2. and a completely negative result from virus exposed in air-chamber.

Experiment 24.—Fresh vaccine virus, rubbed up with glycerine and divided into two portions: one portion placed in air-chamber for twelve hours, exposed to fumes of five drops of carbolic acid volatilized from a rag suspended in air-chamber; five children vaccinated the following day, each from both portions of virus in two different places. *Result:* Examination on seventh day showed eight characteristic vesicles from the ten insertions; one failure from carbolized virus, and one from non-carbolized.

The following vaccination experiments have been made with the assistance of Dr. Smith Townshend, health officer of the District of Columbia, and his assistant, Dr. George C. Samson. The latter gentleman made the vaccinations and reported the results, which have been verified in nearly every case by Dr. Sternberg; points and quills charged with fresh animal virus were used. The experiments have all been made upon unvaccinated children in public institutions in Washington City, and in every case points from the same lot, not treated with the disinfectant, have been used for comparison, the vaccination with these being made in the right arm, and with the disinfected points in the left.

Experiment No. 27, *January* 2, 1880.—Three children vaccinated from quills exposed for four hours in air-chamber (capacity 646 cubic inches, description in Bulletin No. 29) to SO_2, produced by burning 5 grains sulphur (equal to 2¼ volumes SO_2 per 100). Quills Nos. 1 and 2 were exposed dry. No. 3 was slightly moistened with water before exposure. *Result:* Vaccination in right arm successful, and in left arm entirely negative in every case.

Experiment 28, *January* 2.—Five children vaccinated from points exposed in air-chamber for four hours to SO_2, produced by burning 5 grains of sulphur (1 per cent. of SO_2). *Result:* Vaccination completely successful in right arm, and entirely negative result in left arm.

Experiment 29, *January* 2.—Five children vaccinated from points exposed in air-chamber for four hours to SO_2, produced by burning 1 grain sulphur. Atmosphere charged with moisture by boiling water in test-tube communicating with air-chamber by bent tube passing through perforated cork. *Result:* Success in every case in right arm, and negative result in left.

Experiment No. 30, *January* 7.—Five children vaccinated from points exposed for twelve hours to SO_2, produced by burning one-half grain sulphur in air-chamber (dry). *Result:* Four successful in right arm and not in left. One successful in both arms.

REMARKS.—It is evident that the limit of safety as to quantity of SO_2 required for destroying the infection of small-pox in a dry atmosphere has been passed in this experiment, as successful vaccination was practiced with a point exposed for twelve hours to the action of the disinfectant. The fact that the vaccination was successful with only one point out of five in this experiment, and that negative results were obtained in every case where a larger quantity of sulphur was used, indicates that the quantity is not much below that required to accomplish the required result, and it is believed that double this quantity, or 1 grain for a space of 646 cubic inches, may be adopted as a safe standard in disinfection by this agent, when the time of exposure is at least twelve hours. This would be a little less than three grains for each cubic foot of air space. When the atmosphere is saturated with moisture it is probable that a smaller quantity might be efficient, and the following experiment indicates that this is the case.

Experiment No. 31, *January* 7.—Vaccinated four children from points exposed for twelve hours to SO_2, produced by burning one-half grain sulphur in air-chamber; atmosphere saturated with moisture, as in experiment No. 29. *Result:* Successful in every case in right arm, and unsuccessful in left. The results obtained in these experiments, especially those relating to the destruction of the vitality of bacteria (see Bulletin No. 29), are at variance with those reported by Cameron (Manual of Hygiene, London, 1874, p. 325), who says, "similar experiments were made to ascertain the action of sulphurous-acid gas upon bacteria, but this gas was also found to produce but little effect upon these *animalculæ.*" His attention seems to have been chiefly given to experiments with chlorine. My experiments Nos. 4, 7, 10, and 11 show that the burning of one and one-half to three grains of sulphur per cubic foot of air space produces sufficient sulphurous-acid gas to arrest the vital movements of *bacterium termo* in from one to two minutes. Experiment No. 23 shows that the potency of fresh vaccine lymph is destroyed by exposure for twelve hours to an atmosphere in which sulphur has been burned in the proportion of less than three-fourths of a grain per cubic foot, when the virus is in a moist state, rubbed up with glycerine; and the experiments reported above show that in a considerably larger proportion this agent is capable of destroying the potency of fresh animal virus in a dry state upon ivory points.

Experiment No. 32, *January* 7.—Two children vaccinated in left arm from points exposed for six hours to atmosphere containing ten volumes of chlorine in one hundred, and in right arm from points (same lot) not exposed to disinfectant. *Result:* Vaccination in each case successful in right and unsuccessful in left arm.

Experiment No. 33, *January* 7.—Two children vaccinated from points exposed six hours to atmosphere containing two and two-tenths volumes of chlorine in one hundred, and in right arm with points not exposed to disinfectant. *Result:* Successful in right arm and unsuccessful in left in both cases.

Experiment No. 34, *January* 15.—Five children, vaccinated from points exposed for six hours to atmosphere containing one per cent. of chlorine, and with points not exposed to disinfectant. *Result:* In four cases the vaccination was unsuccessful with disinfected points, and in one it was successful; in three cases the points not disinfected gave a successful and in two a negative result.

Experiment No. 35, *January* 16.—Five children vaccinated from points exposed for six hours to atmosphere (dry) containing one per cent. of sulphurous acid gas (collected over mercury), and from five points not exposed to disinfectant. *Result:* Vaccination unsuccessful in each case with disinfected points, and successful with non-disinfected points.

Experiment No. 36, *January* 22.—Three children vaccinated from points exposed for six hours to atmosphere containing one per cent. of nitrous acid (generated by pouring nitric acid on copper filings, and collected over mercury), and from three points not exposed to disinfectant. *Result:* Vaccination unsuccessful in each case with disinfected points, and successful with non-disinfected points.

Experiment No. 37, *January* 24.—Four children vaccinated from points exposed for six hours to atmosphere containing one-half per cent. of chlorine, and from points not exposed to disinfectant. *Result:* Successful in each case with non-disinfected points, and unsuccessful with disinfected points.

REMARKS.—In my chlorine experiments the gas has been produced by the action of hydrochloric acid on peroxide of manganese, and collected over warm water. In all of my experiments with this gas, with a single exception in which one per cent. was used (Exp. 34), the potency of vaccine virus has been destroyed by six hours' exposure. This exception may have been due to an unusual thickness of the coating of dried lymph on the ivory point, and in view of the failure of points exposed to half this quantity (Exp. No. 37) it might perhaps be treated as an exception, especially if a considerable number of future experiments gave a uniformly negative result after exposure to this and smaller proportions of the disinfectant; but, for the present, it will be safer to assume that the limit of safety has been reached if not passed. In Cameron's experiments with chlorine four ivory points, charged with vaccine lymph, were exposed for twenty-four hours in a small chamber made of wood and glass, having a capacity of 16½ cubic feet of space. Chlorine was produced by decomposing bleaching powder (chloride of lime) by acid. Two cases were successfully *re*vaccinated with these points; two failed. In a second experiment six points were exposed and two ounces chloride of lime used. Vaccinations with these points were unsuccessful.

As my experiments now stand, the statement may be made that *exposure for six hours or more to an atmosphere containing at least one per cent. of sulphurous acid gas, chlorine, or nitrous acid gas, is a reliable method of disinfection.*

The following experiment has since been made for the purpose of exposing the above conclusion to an additional test, viz: The destruction of the vitality of bacteria, as proved by their failure to multiply in a suitable culture fluid.

Experiment No. 38, *March* 1.—A number of narrow slips of filtering paper were saturated with urine which had been standing in the laboratory for several days and was filled with bacteria. Some of these slips were then suspended by a thread in each of three half-gallon bottles.

Into bottle No. 1 was introduced a measured quantity of chlorine; in bottle No. 2 of sulphurous acid gas; and in No. 3 of nitrous acid gas; in each case equal to one per cent. of the contained air. After exposure for twenty-four hours little pieces cut from these pieces of filtering paper were used to inoculate boiled urine contained in germ proof tubes prepared as follows: A number of pieces of glass tubing, ¼ inch in diameter and 6 inches long, were closed at one end and bent in the middle to a U shape. These tubes were washed in nitric acid, then in water, and finally heated to redness, to make sure of the destruction of any germs contained in them. Into the closed leg of the U was then introduced a small quantity of boiled urine, and after this had cooled they were treated as follows: Into 1, 2, and 3 was introduced a fragment of filtering paper from bottle No. 1 (chlorine); into 4, 5, and 6, from bottle No. 2 (sulphurous acid); into 7, 8, and 9, from bottle No. 3 (nitrous acid); into 10 and 11, pieces of filtering paper dipped in urine, containing bacteria, and not exposed to a disinfectant; and 12 and 13 were left with the boiled urine only. Each tube was then closed with a plug of cotton, and they were placed in a test-tube rack with the arms of the U dependent—thus ∩. They were observed daily, and all remained clear and free from any appearance of the presence of bacteria, except Nos. 10 and 11, into which the filtering paper not disinfected had been introduced. These tubes became clouded on the second day, and on microscopic examination, at the end of a week, were found to contain an abundance of bacteria.

Experiment No. 39, *March* 10.—Thirteen U tubes prepared as in last experiment. A little boiled urine was introduced into each tube. Three tubes were inoculated with filtering paper which had been dipped into putrid urine containing bacteria, and then exposed for six hours in bottles (capacity 90 fl. oz.) containing ½ per cent. of sulphurous acid gas; three tubes, ½ per cent. of nitrous acid gas; three tubes, ½ per cent. of chlorine; two tubes inoculated with paper dipped in putrid urine and not disinfected, and two tubes left with boiled urine only. The open end of each tube was plugged with cotton. *Result, March* 15: All the tubes are free from bacteria except the two inoculated with filtering paper not disinfected.

Experiment No. 40, *March* 17.—The above experiment was repeated, exposing the filtering paper dipped in putrid urine to ¼ per cent. of the disinfectants for six hours. *Result:* The sulphurous acid tubes broken down in two days, the nitrous acid tubes in four or five days, and the chlorine tubes remained free from bacteria at the end of two weeks.

Experiment No. 41, *April* 3.—The above experiment was repeated, using pure carbolic acid (crystals) as the disinfectant. Twenty grains placed in bottle No 1, ten grains in bottle No. 2, five grains in bottle No. 3; the filtering paper was suspended near the bottom of the bottle. Time of exposure, 36 hours. *Result, April* 11: No bacteria in any of the tubes. Abundant bacteria in tube inoculated with non-disinfected paper.

Experiment No. 42, *April* 12.—The above experiment repeated, using pure carbolic acid, grs. x, grs. v, and gr. i. Time of exposure, six hours. *Result, April* 19: No bacteria in the three tubes inoculated from bottle No. 1 (10 grs.). Abundant bacteria in the six tubes inoculated from bottles No. 2 and No. 3 (grs. v, gr. i).

Experiment No. 43, *April* 21.—Experiment repeated, using *impure* carbolic acid (crude carbolic acid, manufactured by Malincrode & Co., Saint Louis, and sold in New Orleans for disinfecting purposes). Amount of disinfectant used—bottle No. 1, 40 grains; bottle No. 2, 20 grains; bottle No. 3, 10 grains. Time of exposure, six hours.

NOTE.—To favor volatilization, slips of filtering paper were saturated with the crude acid and placed upon the bottoms of the bottles (capacity 90 fluid ounces). The slips of paper to be disinfected were suspended about the middle of each bottle. *Result, April* 24: All the tubes have broken down and have a distinct white film of bacteria upon the surface of the fluid.

REMARKS.—The amount of pure acid required to destroy the vitality of bacteria (10 grains, experiment No. 42) is equal to about 17 pounds in a room 12 feet square and 12 feet high (capacity 1,728 cubic feet), and to fulfill the conditions of the experiment in disinfecting on a large scale, it would be necessary to scatter this amount over the floor of a room having these dimensions, and to suspend articles to be disinfected near the floor for at least six hours, care being taken that all apertures were closed so that the fumes of the acid might not escape. Experiment No. 43 shows that four times this amount (68 pounds) of "crude" acid placed upon the floor of a room of the same dimensions would not destroy the vitality of bacteria exposed in the room for six hours. Experiment No. 24 (Bulletin No. 29) shows that an amount of the impure acid equal to 46 fluid ounces volatilized in the same room will not destroy the potency of vaccine virus, in a moist state (rubbed up with glycerine), when the time of exposure is twelve hours. Finally, these experiments show that the popular idea, shared, perhaps, by some physicians, that an odor of carbolic acid in the sick-room, or in a foul privy, is evidence that the place is disinfected, is entirely fallacious, and, in fact, that the use of this agent as a volatile disinfectant is impracticable, because of the expense of the pure acid and the enormous quantity required to produce the desired result.

APPENDIX E.

REPORT ON DETERIORATIONS AND ADULTERATIONS OF FOOD AND DRUGS.

By Dr. CHARLES SMART, *Assistant Surgeon, U. S. A.*

[Undertaken in accordance with instructions from the National Board of Health.]

To institute a thorough examination into the prevalence of food adulteration would occupy a much longer time than has been accorded the writer for this investigation. The number of articles which enter into the food supply is so great that many of them had of necessity to be omitted. Hence, milk, butter, wines, and liquors, preserves and canned goods, &c., do not appear on the following record. The articles which were first presented for examination were accepted, and work having been commenced upon them it was continued, sample after sample, until a sufficient number of specimens had been examined to enable a general statement to be made concerning their condition. Nevertheless it is believed that the investigation, limited as it has been, will be found to have fulfilled its intention definitely.

Some difficulty was experienced in obtaining the samples. A circular was issued to State and municipal health boards requesting their co-operation, but the number of specimens gathered by this means was very small. In the mean time, through the kindness of Dr. Smith Townshend, health officer of this city, many samples of various articles were procured from first-class stores. These were accepted and investigated as illustrative of the character of what might be expected to be pure goods. The dealers who voluntarily furnished them were aware of the object intended in making the collection, and it is hardly to be supposed that any of them would have knowingly sent in an adulterated article. If these specimens had proved to be all pure and unadulterated, the results would have had no bearing in connection with this report, but if, as proved to be the case, samples of adulterated goods occurred among them, each such sample would have a greater value as bearing on the prevalence of adulteration than if it had been bought at a store where adulteration, if prevalent, might be expected to be found.

A number of the specimens examined were due to the courtesy of the Commissary-General of Subsistence of the Army. These consisted chiefly of flours brought in from military posts and depots in different parts of the country, and of pepper, ground spices, and baking-powders in cans procured from manufacturers and wholesale dealers. As these samples were liable to be examined by inspectors and Army boards, the presumption in favor of their purity was nearly as strong as in the case of the specimens sent in by the dealers of this city; and correspondingly an adulterated article occurring among them would have a larger meaning than if it had been bought in some of the low-class stores of this or any other city.

Failing a response from the health boards addressed by circular as aforesaid, permission was obtained to make purchases in the poorer districts of this city; but as the appropriation for this purpose was small, an effort was made to economize it by buying only the smallest purchasable quantity of each article. This led to difficulty in obtaining specimens. The dealer had a curiosity to know why such purchases were made, and becoming suspicious from the hesitation of the messenger, immediately refused to furnish the articles. The writer made several purchases in person and experienced this treatment—the previously courteous storekeepers becoming resentful and even aggressive when the object was purposely made known to them. This, when taken in connection with the subsequently-ascertained character of purchases in similar localities, leads to the supposition that the percentage of pure articles in this report has not been decreased by their refusal to sell.

A larger appropriation having been made by the executive committee, no further trouble was experienced and the necessary purchases were made in this city, in New York, and in Baltimore, Md.

This report therefore embraces the results of the examinations of two series of samples, one of which was derived from sources whence purity might be expected, and the other from sources which might be presumed to yield low-grade, if not adulterated, goods.

A great deal of sensational writing has appeared from time to time concerning food adulteration, the text of which has mainly been derived from English experience. Loose statements have been made even in official reports which have fostered the sensational outcry until it has reached such a pitch as to suggest the defeat of its ob-

ject by creating a prejudice against itself. Compilations from Hassall's book have been published as personal experience, and quoted so often that the people have become tired of hearing about food adulteration, and discredit the whole thing, except perhaps that milk may sometimes be watered. Statements of individual facts are required to place the subject on a sound basis, and for this reason, while a general summary of results is presented as the body of this report, there is appended an itemized list of the facts developed during the investigation.

A careful comparison of the results with the facts developed during the investigation by the English committee, twenty-five years ago, shows clearly that food adulteration is practiced in this country at the present time to as great if not to a greater extent than prevailed in England at the time of the agitation which led to the enactment of repressive laws. Our corn-meal and lard are pure; our wheat-flour is not mixed with alum, but the bakers use it; our sugars are cleaner, but we have glucose admixtures which the English had not; and if our coffees are better, it is owing more to the practice of home grinding bequeathed to us from the early days of the country, when grocery stores were not so common as they are now. The few samples of loose coffee which were found to be adulterated show that there is a tendency to debase the article, which would no doubt increase as the coffee-mills disappear from our kitchens until the condition of the market would be represented by the trash which is now sold as package coffee. On the other hand, the remainder of the articles included in this report are found to be in as bad, and many of them, as the peppers, allspice, cinnamon, &c., in a worse condition than were the English supplies when official attention was directed to them.

Fortunately, with such exceptions as the alum in bread and baking materials, the sulphate of lime which oftentimes replaces cream of tartar in household baking, the debasement of milk by dilution, and the poisonous pigments used for coloring confectionery, the adulterations cannot be considered as deleterious. They affect the pocket of the individual rather than his health; so that, to use the words of the committee appointed by the National Board of Trade to award prizes for the best draught of an act repressive of adulteration, "the question of adulteration of food should therefore be considered not so much from a sanitary standpoint as from that of commercial interests; as being of the nature of a fraud in aiding the sale of articles which are not what they are represented to be."

Seven hundred and thirteen samples were examined. Of these 304 were obtained from sources which implied purity, as already explained, and 409 from those which might be considered suspicious. Of the former, 24, or 7.89 per cent., were found to be of such a character that under a law repressive of fraudulent adulteration prosecution might have been instituted with full prospect of effecting conviction. Of the latter, 183, or 44.74 per cent., would have been in like manner condemned.

But these percentages, although they appear to give expression to the prevalence of adulteration, in reality convey no meaning. Lard and corn-meal were found to be unadulterated. If, instead of a few samples of these articles, enough to determine their general character, a large number had been included in the report, the percentages of impurity would have been proportionately diminished, but the facts would have remained the same. So, had the examinations of ground spices been multiplied, the percentages of impurity would have been increased. To appreciate the condition of things the facts relating to each article of supply must be considered separately.

TEA.

Those who desire to present a strong case concerning the prevalence of adulteration in food regard the facing on green tea as authorizing them in giving that article a place on their list of illustrations. Chinese teas are dusted with Prussian blue, and Japan teas with indigo along with finely pulverized sulphate of lime and silicates.

If these substances were suspected of being deleterious in the quantity present on the most coarsely-faced specimens, the green teas should undoubtedly be condemned. But there is no evidence to show the unwholesomeness of the facing. If the color hid the quality of the leaf, so that a poor tea might be passed off as a superior article, some action might be warranted, but the color can be removed easily and the leaves judged by their natural appearance. Indeed, the facing itself constitutes a criterion of quality, it being invariably fine or coarse as the leaves are young and high-priced, or old and cheap. Again, if the powder were used in such quantity as to be a substitute for a notable weight of the leaves, an objection to its use might be in place. But the facing seldom adds materially to the weight. Some of the greens which were examined contained less mineral matter than the unfaced black teas. The average ash of clean Oolongs, which are but slightly dusted, was found to be 6.29 per cent. of the dry tea, while that of similarly clean but regularly faced greens was 6.20 per cent. The sand and clay which black tea gathers during its fermentation is more than an offset to

the pulverulent facing applied to the greens, as the minimum of ash in the Congous is 6.47 per cent. Lastly, green tea is purchased for importation with a full knowledge on the part of the purchaser concerning the existence of the facing. There is no deception or attempt at deception now, although the practice of coloring may have originated in an effort of this kind.

The English law until lately made the mistake of regarding the facing of tea as an adulteration. This law was grievously oppressive to retailers, many of whom were prosecuted and fined and their business and characters injured for selling tea in good faith in the same state in which it was imported from China, and on which the customs had received tea duty. The wholesale tea trade of London submitted a memorial to the chancellor of the exchequer suggesting that each chop or parcel of tea should be sampled and examined by sanitary inspectors before being admitted for home consumption, and that the prosecution of retailers be suspended until the food-adulteration act should be amended in this respect. As a result of this memorial, the ninth annual report of the local government board gives a summary of the work of the analyst of the commissioners of customs during the year 1879, from which the satisfactory character of the teas imported may be ascertained. Of 575 specimens only seventeen were of such a character as to require the board's directions as to their disposal, but as fourteen of these were allowed to be delivered without any restriction, there remained only three for special action, and only one of these, fresh-water damaged, was condemned to be destroyed, while one with old and exhausted leaves was allowed to be delivered for exportation only, and the third, plundered in China and the weight made up with sand, was sifted and repacked. The facing of the greens was light.

It is probable that if such a system of customs inspection existed in this country our importations would be found to be in equally satisfactory condition. This is deduced from the fact that of eighty-eight teas which were presented by dealers for examination, and which represented all qualities, at prices ranging from 33 cents to $1.40 per pound, not one sample was found to be debased in any way. Some contained a larger amount of mineral matter than others, but in none did this exceed what might be allowed as incidental to the gathering, fermenting, drying, and other processes necessary to the preparation and preservation of the leaves. One sample contained a small piece of iron, probably accidentally present, as a careful search showed it to be the only fragment of the kind. Two specimens contained numbers of minute pebbles, about the size of a pin-head, and as these occurred among leaves of a quality on the preparation of which great care is usually expended, it is hardly possible to suppose their presence unknown to the individuals concerned in the preparation. In these cases the mineral addition was so small, 1 per cent., that but for the superior quality of the tea they might have been passed over as accidental.

The mixture of teas of different qualities or values is undoubtedly practiced by dealers in this country, as in England. Many of the samples showed leaves which were unmistakably of different parcels. But this appears to be a point with which legislation should have no concern. If the sample consists of tea leaves, or fragments of tea leaves which have not been debased by exhaustion or mineral addition, there is no imposition on the purchaser, no matter what price he pays for the article. Many old and low-priced teas yield as much theine, as much soluble salts, and as much extractive as younger and high-priced samples. The difference lies in the aroma, but this is a matter of luxury, not of food.

The teas examined numbered 117, but of these two which were grown in Georgia and six sent specially from Japan may be excluded from present consideration. Of the 109 remaining, 90 were obtained from sources which presumably should have furnished a pure article, while 19 were purchased at such stores as might be expected to furnish an adulterated article, if adulteration was at all prevalent. In no case was a leaf observed which was not a true tea leaf. Of the 90 the only cases of debasement were those already mentioned as having probably originated before importation, while five of the 19 were so deteriorated that an analyst would have been warranted in reporting them as fraudulently adulterated—one, gunpowder (Y 2), from an excess of lime sulphate facing; one, imperial (W 2), from admixture with sand, and three, imperials (Y 1, 2, and 3), from the presence of exhausted leaves. Whether these debasements were effected in China or in this country is an open question; but from the character of the English importations it is probable that exhausted leaves are dried and recolored in this country for sale among the poorer classes of the community.

The following represents the tea samples and the results of their examination according as they would have been approved or condemned by a public analyst, A indi-

cating their derivation from a source where the presumption was in favor of purity, and Z from one where adulteration, if prevalent, might be expected to be found:

	A.	Approved.	Condemned.	Z.	Approved.	Condemned.
Congous	6	6	....	2	2	....
Pekoes	2	2	....	......	....	....
Oolongs	31	31	....	4	4	....
Gunpowders	29	29	....	2	1	1
Imperials	12	12	....	7	3	4
Hysons	7	7	....	3	3	....
Japans	11	11	....	1	1	....
Total	98	98	....	19	14	5

COFFEE.

In England the chief adulterant of coffee is chicory. Dr. Hassall testified before the food commission, in 1855, that of 34 samples which he had examined 31 contained chicory. Normandy found as much as 75 per cent. of chicory. Besides the chicory, evidence was given as to the occasional presence in coffee of roasted wheat and beans, rye and potato flours, mangel-wurzel, and a substance resembling acorns, roasted corn, and ground cocoa-nibs; while as adulterations of the chicory there were instanced deal and mahogany sawdust, carrots, Venetian red, and burnt sugar. The annual consumption of chicory in England when compared with that of coffee shows that the latter must contain about 40 per cent. of the former. But as the English palate likes the taste of chicory, while the individual objects to the trouble of mixing, provision is made by law for the sale of the mixture with a label attached bearing a statement of its character. Nevertheless, so great is the tendency to adulteration, that in 1879, out of 1,244 samples of coffee examined by the analysts, 236, or 18.9 per cent., contained chicory.

In this country we apparently prefer our coffee pure, as the common practice is to purchase the roasted beans and grind them as required; and although we are occasionally quoted as being responsible for wooden nutmegs, we have never been accused of manufacturing coffee beans from compressed chicory as has been done in England. Most of the dealers with whom I have conversed have been strong in their belief that adulterated coffee is not to be found in this country, as the beans are either home-ground or ground by the supplying grocer. The results of H. B. Hill's examination for the State board of health of Massachusetts sustain this opinion, as ten samples of ground coffee obtained in bulk were found to be pure, while seven package samples consisted of one with no coffee, two with very little, and four with from 50 to 70 per cent. of coffee, the rest being roasted wheat, pease, beans, and chicory. But the supplying grocer is not to be trusted in all cases, as out of the few purchased samples of loose, ground coffee which have been examined during the present investigation one contained a small percentage of chicory while two consisted largely of chicory and roasted beans. Only one sample of package coffee was received, and it sustained the accuracy of Dr. Hill's results. Chicory, corn, wheat, and rye were noted on the microscopic field as adulterants; but adulterants of what? For no coffee had been discovered, and half a dozen successive slides carefully examined failed to show the presence of the nominal article.

Three extracts or essences of coffee were examined, one of which consisted of chicory and the two others of roasted starches. Two of these bore on the label an offer of a reward for proof that any other extract of coffee was as pure as they, which does not say much in a general way for the purity of extract of coffee. Two samples of chicory were examined, both of which were found pure.

In the following tabulation of the results the letters A and Z, respectively, represent, as in the case of the teas, the presumption as to quality:

	A.	Approved.	Condemned.	Z.	Approved.	Condemned.
Loose coffee	5	5	....	24	21	3
Package coffee	.....	....	....	1	....	1
Essence of coffee	.....	....	....	3	......	3
Chicory	.....	....	....	2	2	....
Total	5	5	....	30	23	7

SUGARS AND SIRUPS.

At the time of the food-adulteration agitation in England, sand in sugar was a phrase familiar to the ears of the people. But it seems probable that in most instances the sand was the result of imperfect refining and careless handling. Most of the sugars then examined were dark in color, mixed with much vegetable extractive and

swarming with the sugar-mite. The sugars now in the market are infinitely cleaner, and the *acarus* is seldom seen. Nevertheless, in most of these, the microscope can discover dust particles which would give the sensationalist a verbal license for an outcry of impurity. But the dust in sugar discoverable by the microscope is like the motes in the air which require the sunbeam to make them visible.

The health department of the city of New York in its third annual report, 1873, gives a record of the examination of 109 powdered sugars which agrees with the results obtained during the present investigation: 45 were pure and good; 51 contained accidental dust; 8 contained considerable dust or dirt; 5 were very dirty, but in no case was there any intentional adulteration.

Of the 124 samples of all kinds of sugars which are recorded hereafter, 57 were microscopically clean, 64 contained accidental dust, 3 were foul and swarmed with the sugar-mite.

Of late years a saccharine substance, glucose, less sweet than cane sugar, but, so far as known, possessing all its nutritive qualities, has been manufactured from starch by boiling with sulphuric acid and afterward removing the acid by means of lime. It has been asserted that this substance is largly used for the fraudulent adulteration of sugars.

In 1879 the public analysts of England examined 234 sugars, and found but one of the specimens adulterated. The 109 samples of powdered sugar reported by the health authorities of the city of New York in 1873 were free from glucose, and the purity of the sirups and brown sugars sold in that city was also established. In the absence of experimental proof concerning the condition of the sugars at the present time, these facts might be quoted as indicating the probabilities. As it is, they are mentioned to show how little value such quotations may possess. Adulteration by glucose is certainly practiced, and its extent may be suggested by the following figures: Among 47 brown sugars, most of which were furnished by dealers who knew that their samples would be examined, there were found 3 which contained glucose, while among 38 samples purchased for analysis, no less than nine were thus adulterated. The glucose varied from a small admixture to 30 per cent. A remark by one of the dealers who furnished a 30 per cent. sugar is worthy of mention in this place: "Oh! they all have it, but they don't send any of it to *you*." Another store-keeper from whom a degraded sugar was obtained, remarked, as he was putting up the samples, that I was welcome to anything he had, as he did not suppose he was any worse than his neighbors.

The white sugars, powdered, granulated, &c., were free from this adulteration; 24 of them were furnished by dealers and 15 were purchased. The sirups also, of which 21 were sent in for examination and 12 purchased, were also pure. Professor Kedzie, in the Michigan State Board of Health Report, 1874, gives a record of the examination of 17 sirups, only 2 of which were pure; the others were glucose, and contained sulphate of iron and lime. The lowest stated quantity of the iron salt is 25 grains per gallon; of the lime 100 grains; and the highest 58 grains of the former, and 724.83 of the latter per gallon. At that time the glucose must have been put on the market as sirup, while it now appears as sugar. But the glucose sugars are of superior make to Professor Kedzie's sirups. None of them show any free sulphuric acidity or excess of iron or lime. They are indeed a wholesome article of food. Starch is changed into glucose during digestion. By making use of corn-meal or wheaten flour one can furnish his system with all the food elements which are contained in cane sugar or in glucose. So far as nutrition is concerned, there is no occasion for paying a price to the manufacturer as a middleman. But sugar and glucose have an economic value as sweeteners which starch has not; and as this value is greater in the sugar, the presence of glucose, an article of less price as well as of less economic value, is a fraudulent, although not an unwholesome, adulteration of the sugar. Starch sugar, properly prepared and sold as glucose, and at the price of that article, would be a boon to the poor. Many of them use it now, in part, but pay the price of cane sugar for it.

No tin or other unwholesome substances, sometimes stated to be used by refiners, were found in the specimens.

In tabulating the results, A and Z represent the origin and probable quality of the specimens as already explained.

	A.	Approved.	Condemned.	Z.	Approved.	Condemned.
Loaf	......	......	....	2	2	....
Crushed	......	......	....	1	1	....
Pulverized	8	8	....	10	10	....
Granulated	16	16	....	2	2	....
"A"	8	8	....	1	1	....
"C"	9	9	....	......	......	....
Various	30	27	3	37	28	9
Total sugars	71	68	3	53	44	9
Sirups	21	21	....	12	12	....

FLOUR.

The results of the flour analyses are highly gratifying. Of 58 specimens which were examined, only one contained matter foreign to the wheat kernel, and in this case the adventitious substance was corn-meal, evidently introduced by accident. Five samples were so deficient in gluten that it is doubtful if good bread could have been made from them; but this arose not from willful adulteration, but from natural causes. Our merchants have so many flours rich in gluten that a poor flour should not be found in the markets. Mixing or blending is permissible in the case of flour. Ten to twelve per cent. of gluten is required to make good bread. Some believe that better bread can be made from a 10 per cent. sample than from one which contains a larger quantity of gluten, but this is questionable. Mr. Brown, a flour dealer of large experience, testified before the English food committee that he endeavored to meet the wants of the bakers by mixing bean flour with his wheat in order to increase the quantity of nitrogenous matter. According to his statement, the loaf should be of white color and of a good height, the corners free from a doughy skin, the crust not to dye of a brown color. It should cut with smoothness, with a plain surface, and no large holes. To obtain this loaf from English flour, which contains only 10 per cent. of gluten, the addition of a small percentage of bean flour was necessary. But in this country, with flour which contains as much as 17.5 per cent. of gluten, there is no occasion for the use of beans. The starch and other nutritive principles of a weak flour can be utilized in bread-making by mixture with flour of a stronger or more glutinous quality. A certain percentage should be prescribed as the minimum consistent with marketable quality. Nine per cent. has been chosen as the minimum in making out this report, which returns 5 of the 58 specimens deficient, but perhaps this minimum is too low; it is certainly not too high.

Twenty-five years ago, in England, Normandy testified that he had scarcely found a flour which did not contain alum to some extent. Improvement has taken place since then, mainly through conviction under the food-adulteration act. Yet last year the English analysts found in 601 samples of flour 15 specimens, or 2.4 per cent., adulterated with alum.

BREAD.

But although our millers and flour dealers do not make use of alum, there is no doubt as to its employment by the bakers. Of 18 samples purchased in the city of Washington, D. C., 8 contained it. Long ago Hassall reported to the English food committee 24 samples in which alum was present in all, while Normandy expressed the prevalence of the practice by reporting that he found one bread in which alum was *not*. The British analysts, in 1879, examined 1,287 breads, of which 95 or 7.3 per cent. were reported against as being adulterated with alum, and since the use of this substance is prohibited by the adulteration act, it is clear from the continuance of the practice that the bakers must find it to their advantage. But, on general principles, the advantage to the public of what is profitable or advantageous to the bakers would seem to be doubtful.

The unwholesomeness of alum is by no means universally accepted. If the alum existed in bread as alum, and was introduced into the system as such, it would, from its powerful astringent properties, interfere materially with digestion, and be properly viewed as a deleterious ingredient. But it is well known to chemists that when water is added to alumed flour in the process of dough-making, a chemical change takes place whereby the alum is converted into an insoluble powder. This insoluble powder, which is generally believed to be inert, has been proved by Professor Patrick, of the University of Kansas, to be unaffected by the juices of the stomach. Alum would, therefore, appear to be harmless. But there is another view to be taken of the subject, looking to its action in the bread itself. One of the objects of its introduction is to check the process of fermentation which may be taking place in poor flour, so that the bread made therefrom is whiter and contains less dextrin and starch sugar than if no alum had been added. So far its action is preservative and of value, but it is accomplished at the expense of the nutritive principles of the flour. Phosphoric acid, from the soluble phosphates of the grain, is precipitated along with the insoluble alumina in the bread-making process; and, what is of more consequence, the digestibility of the bread is impaired by the presence of the alumina and its phosphate. J. West-Knights, F. C. S., in a paper read before the Society of Public Analysts during the present year, records the results of digestive experiments on alumed and unalumed breads. The former left a larger residue of unsolved matter after treatment with an artificial gastric juice. Nevertheless there are no cases on record where disorder of the digestion is unmistakably due to the use of alum. There are many declamatory and unsound passages in books concerning the unwholesomeness of alum in bread; but impartially viewed, the evidence appears to give ground for regarding it as an adulteration which should be suppressed. As alumed baking-powders are in such general use, this subject is worthy of a thorough investigation.

Dr. Elwyn Waller, in the Fourth Annual Report of the Health Department of the city of New York, reports upon the bread sold in that city: Of 51 samples 41 contained no adulterant; 2 contained copper, probably added as sulphate; 6 contained an excess of alumina, and 2 both alum and copper.

Alum, however, was the only adulteration found during the present investigation.

CORN-MEAL.

The corn-meal gave such satisfactory results that it was deemed unnecessary to continue the investigation after twenty samples had been examined. These were found to be of excellent quality and free from any extraneous matters. Sixteen of the twenty were obtained by purchase.

LARD.

In England lard has been found much adulterated with potato-flour, water, salt, carbonate of soda, and caustic lime; but of fourteen samples purchased in Washington City all were found to be of excellent quality. The results being so uniform, it was considered unnecessary to increase the number of samples.

BICARBONATE OF SODA.

Commercial bicarbonate usually contains a small percentage of sulphates and chlorides, and a specimen is rarely found which does not present traces of sulphur salts. These impurities are accidental, and can only be regarded as an adulteration when the percentage is unusually high. Of the 12 samples which were examined, 9 were poor specimens of the commercial article, 2 contained about 10 per cent. of impurity; enough certainly to condemn them as failing in purity; while 1, from exposure or imperfect preparation, showed a deficiency of carbonic acid corresponding to the presence of 25 per cent. of the neutral carbonate. No markedly fraudulent adulterations, as with large percentages of terra alba or starch, were discovered; but it is probable that if the list of samples had been increased some notably bad specimens might have been obtained; for in 28 samples reported in the Third Annual Report of the Health Department of the city of New York, while 26 were of the ordinary commercial character, 1 contained flour, and 1 nearly 25 per cent. of terra alba.

CREAM OF TARTAR.

Commercial cream of tartar contains tartarate of lime, which must, within limits, be accepted as natural to it. Some cases have been tried recently in England in which the adulteration charged was the lime tartrate present in this salt, but the magistrate properly refused to convict. Were this the only ground of complaint against the cream of tartar of the grocery stores, it would pass with the bicarbonate as being generally of ordinary purity; but unfortunately this is not the case. It is, on the contrary, one of the articles which are subject to gross adulteration. Only 18 samples were examined, but these were considered to be enough, in view of the character of the results. Six were of satisfactory purity. Eleven contained sulphate of lime, varying from 17 to 90 per cent.; three having nearly the latter figure. Two contained no cream of tartar, but consisted, instead, the one of sulphate of lime, alum, and acid phosphate of lime, and the other of alum, acid phosphate, and potato-starch. Corn-starch was also found in large proportion in one of the lime sulphate powders. Considering the use of cream of tartar in baking, its impure condition is a serious evil.

The samples examined cannot be considered as exceptionally impure, for similar results have been recently reported by the Massachusetts Board and the New York City Health Department. Of nine New York samples, one had 86 per cent. of terra alba, one 61 per cent., and the others contained this lime-salt, but the quantity was not determined.

BAKING-POWDERS.

Eighteen specimens were obtained, 6 of which were purchased, while 12 were furnished by the Commissary-General of Subsistence of the Army in unopened sample-cans. The acid salt of the latter consisted in every instance of cream of tartar. Of the purchased specimens one contained alum, another acid phosphate of lime, while the remaining four consisted of a mixture of these two salts. The alkaline salt was in all bicarbonate of soda. The starch used in the manufacture was generally corn-starch, but wheat-starch and wheat-flour were found, and mixtures of these with corn-starch. In one case powdered gum took the place of the starches. Small fragments of woody tissue existing as impurities in the gum were probably intended to suggest to the public the presence of ground malt. One of the starch powders was flecked with minute woody particles, probably with a similar intention. The quantity of starch varied from

6 to 55 per cent., but the value of a baking-powder depends, other things being equal, on the amount of carbonic acid which it furnishes during its decomposition. The gas in these samples ranged from 4.1 to 16 per cent. of the weight of the powder. The price, however, was not the same in all cases, so that the powder which yielded the largest percentage did not necessarily supply the gas at the lowest price. Again, some of the cans contained in excess of their nominal weight, while others were deficient. The materials in every instance appeared to be of good commercial quality, to be thoroughly mixed, and to be pretty well proportioned, the excess, except in one case, being on the side of the bicarbonate, to prevent undue acidity in the articles of diet prepared by their aid.

Nothing can be said against the cream of tartar powders, except that some of them were deficient in active properties (4.1 per cent.) which would correspond with a dilution or adulteration by starch. A minimum limit is needful in these cases.

The acid phosphate powders contain a percentage of sulphate of lime, which is due to the method of manufacture. It is unlikely that the quantity present in a carefully prepared powder would be unwholesome. When sold as phosphate powders and at the cheaper price of phosphate powders, there is, from the point of view of this report, no objection to their use, provided a limit is placed upon the accidental lime sulphate so that it may not form the nucleus for willful additions.

The alum samples must be considered as adulterated baking-powders, since none of them gave information by the label concerning their character. They are imposed upon the public by manufacturers and dealers in the effort to undersell each other, and are sold on the merits, if not by the name, of cream of tartar powders. But if these powders were sold as alum powders, and at the price of alum powders, there would be no adulteration. Thus while alum in bread would be considered and treated as an adulteration, alum in baking-powder might have to be reported as pure. A label in such a case would diminish the sale, but would not prevent the use of these powders among those who most require supervision in sanitary matters—the poor and ignorant. A proscription of alum from bread and baking materials would be required to afford them effectual protection.

BLACK PEPPER, GROUND.

The examination of the ground black peppers and spices shows to what extent adulteration may be practiced when its detection by the public is a matter of difficulty. The dealer himself appears to have lost the knowledge of the characters of the pure article, as out of four samples sent in by respectable houses in this city for the purpose of being examined, only one was pure. The others contained baked flour and rice with sand enough to prove the unclean condition of the peppers when milled.

In 1855 Dr. Hassall reported 43 specimens from the English stores, 16 of which were adulterated, 4 with wheat-flour, 1 with pea-flour, 2 with rice, 4 with mustard, 3 with linseed-meal, and 2 with P. D., which last was understood to be a trade name for a mixture of linseed cake, mustard dross, and cayenne pepper, used by black-pepper manufacturers. The chemist of the board of internal revenue gave the results of a larger experience. Of 1,116 peppers, 576 were adulterated with rice, sago, potato-starch, burned chillies, brown and white mustard, wood, wheat bran and flour, oat-flour, and ground gypsum. This unsavory record is not improved by the results of the present examination. Four of the specimens have been already mentioned. The Commissary-General supplied 16 unopened sample-cans for investigation. Of these, 2 were adulterated with fresh and baked wheat-flour, while 6 showed, from the quantity of sand present, the unclean and probably inferior quality of the peppers. Of 32 samples which were purchased 4 were pure, but the sand showed their inferior character, 3 per cent. in one case being perhaps more than ought to be allowed as consistent with purity. The remaining 28 samples were mixed with large percentages of baked flour, rice, corn, beans, mustard, and linseed husks, cayenne, and turmeric; 3, 4, and 5 per cent. of sand were also found in some of them. In the case of sugar, the microscopic dust was specified as being of no practical account. Here, on the contrary, the substances mentioned, which were discovered by microscopic examination, constituted the body of the sample, pepper having been added simply as a flavoring agent.

ALLSPICE, GROUND.

This substance, which was found by the English committee to be seldom adulterated, is with us largely mixed with such articles as bread-crusts, beans, corn-starch, woody tissues, and turmeric. Five samples from sources which presupposed purity were found to be pure; but of 23 which were purchased 11 were allspice only in name.

GINGER, GROUND.

Dr. Hassall reported 17 specimens out of 21 as adulterated with sago, potato, wheat, and rice starches, cayenne, mustard, and turmeric. The present examination revealed

the presence of similar adulterants. Five specimens, which came from good sources, were pure; but one of them contained 3 per cent. of sand, which is too high to be accidentally present in a good article. Of 11 purchased samples 6 contained wheat-flour, corn-starch, rice, bran of wheat, husks of black pepper, and turmeric. Some of these contained over 5 per cent. of sand.

MACE, GROUND.

Only 8 samples of mace were purchased, as the uniformity of the results indicated the prevalence of adulteration. Most of these contained very little mace, but were mainly composed of corn and wheat flours and starches, wheat-bran, rice, beans, and turmeric. Even the three samples which were voluntarily presented by first-class houses in this city were not all pure. One was mixed with wheat-starch.

CLOVES, GROUND.

Four samples from unexceptionable sources were found to be pure; but only 3 of the 20 purchased specimens were free from other and cheaper vegetable substances. Allspice constituted in several instances the bulk of the so-called cloves, alone, or usually mixed with large percentages of corn, wheat, and beans.

CINNAMON, GROUND.

Out of 26 samples of ground cinnamon, one was found to be unadulterated. This exceptional specimen came from the office of the Commissary-General of Subsistence, United States Army. Two others which were furnished from that office were adulterated with almond-shells, roasted beans, and various starches. The single sample which was sent by a first-class Washington dealer contained baked wheat-flour. Of the 22 purchased specimens, 3 would have been reported pure if they had been sold as cassia, but the others contained, in addition to cassia, corn, wheat, beans, allspice, almond-shells, and turmeric. Three contained also an unwarrantable quantity of sand and red clay.

CAYENNE PEPPER, GROUND.

Two samples of pure cayenne were found; one was furnished by a dealer in Washington, the other was a purchase in that city. On the other hand, three sample-cans from the office of the Commissary-General and 13 purchased samples were adulterated. The adulterants were generally corn-flour, or starch and turmeric, but fresh and roasted wheat, rice, linseed, logwood, deal sawdust, and red clay were also found. The only gratifying point in connection with these samples is the absence of red lead, a deleterious addition, which Hassall found in 13 of 28 English specimens.

MUSTARD.

Of 27 samples examined 6 were found to be pure, but 4 of these were obtained from the medical purveyor, and were intended for medicinal purposes, while 2 were purchased in Washington City. Of the 21 adulterated specimens, 2 were furnished by dealers and 19 purchased. The adulterants were principally wheat-starch, or flour and turmeric, but corn-starch, rice, cayenne, and sulphate of lime were also fonnd.

VINEGAR.

The only adulteration discovered in the 15 samples of vinegar which were examined was dilution by water. The strength varied from 2.56 per cent. of monohydrated acetic acid to 7.12 per cent. A minimum limit must be established. Allowing 3 per cent. to constitute this limit, 3 of the 15 would have to be condemned. Iron was present in some of the samples, but only in traces. No copper, lead, or other dangerous metals were found, nor any free mineral acids. The third annual report of the State board of health of Massachusetts, 1872, gives the result of the examination of 12 cider and 10 wine vinegars. Of the former, 1 contained free sulphuric acid, while 8 of the latter showed traces of free acid, and 2 contained lead.

PICKLES.

Only one sample was furnished for examination—the pickles of the Navy ration. They were of good quality and free from copper coloring and mineral acids.

Recently E. H. S. Bailey, of the Lehigh University, examined a bright green pickled

cucumber weighing 2 ounces, and found it to contain copper equivalent to one-seventh of a grain of the sulphate. H. B. Hill, assistant in chemistry at Harvard College, examined 12 pickles (probably selected on account of their suspicious color). Ten of the specimens contained copper in quantities varying from .0009 to .0077 per cent.

COLORED CONFECTIONERY.

No quantitative examinations were made, as the time at command did not permit, but as poisonous agents are reported to have been used for coloring confectionery it was deemed important for the purposes of this report to make at least some qualitative investigations. Most of the candies which were purchased were red—13 samples—and owed their color to cochineal; but a sufficiency of yellow colored specimens were obtained to show that lead continues to be the basis of such colors. Of 5 yellows, 3 contained lead, 1 antimony, and 1 turmeric.

These candies, excluding from consideration the poisonous coloring matter, were of great purity. All were made from cane sugar, and were free from sulphate of lime and practically free from starch. The largest quantity of starch was found in some solid looking lozenges which contained a small proportion of baking-powder, by means of which the starch was apparently introduced.

In the third annual report of the New York City health department a record is given of 10 yellow-colored candies, 5 of which contained lead and 1 gamboge. But H. B. Hill, of Harvard College, has made the most complete investigation into this subject. He examined 77 samples. Of these 24 contained a small and 14 a large percentage of starch, while 5 contained a small and 2 a large percentage of sulphate of lime—one of the latter having nearly 60 per cent. Lead was reported present in 19 of 21 yellows and 11 of 12 orange colors. In 29 reds, 3 contained iron, 1 mercury, the rest having vegetable coloring matter. In 5 browns, 4 contained iron. In 4 blues, 2 contained ultramarine; and in 7 greens, 6 contained Prussian blue, with lead, and in one case arsenic.

E. H. S. Bailey, of Lehigh University, kindly furnished the writer with notes of an examination of a yellow-colored candy sold as lemon balls. The color was due to chromate of lead, which was present in such quantity as would give 7 grains of metallic lead in every pound of the candy.

Summary of the articles examined, with results.

[Those returned as condemned were of such a character as would justify prosecution in case of the existence of a law to prevent the adulteration of food.]

Articles.	A			Z		
	Number.	Approved.	Condemned.	Number.	Approved.	Condemdne.
Teas:						
Congous	6	6	......	2	2	......
Pekoes	2	2	......	......	......	......
Oolongs	31	31	......	4	4	......
Gunpowder	29	29	......	2	1	1
Imperials	12	12	......	7	3	4
Hysons	7	7	......	3	3	......
Japans	11	11	......	1	1	......
Coffee:						
Loose	5	5	......	24	21	3
Package	......	......	......	1	......	1
Essence	......	......	......	3	......	3
Chicory	......	......	......	2	2	......
Sugar:						
Loaf	......	......	......	2	2	......
Crushed	......	......	......	1	1	......
Pulverized	8	8	......	10	10	......
Granulated	16	16	......	2	2	......
"A"	8	8	......	1	1	......
"C"	9	9	......	......	......	......
Various	30	27	3	37	28	9
Sirups	21	21	......	12	12	......
Flour	30	27	3	28	26	2
Corn-meal	4	4	......	16	16	......
Lard	......	......	......	14	14	......
Bread	1	1	......	18	10	8
Baking-soda	1	1	......	11	8	3

Summary of the articles examined, with results.—Continued.

Articles.	A.			Z.		
	Number.	Approved.	Condemned.	Number.	Approved.	Condemned.
Cream of tartar	1	1	......	17	5	12
Baking-powders	12	12	....	6	1	5
Black pepper	20	15	5	32	4	28
White pepper	1	1	......	...	...	......
Allspice	5	5	......	23	11	12
Ginger	6	5	1	11	5	6
Nutmegs	......	......	....	1	......	1
Mace	3	2	1	8	......	8
Cloves, whole	......	......	......	5	5	......
Cloves, Ground	4	4	......	20	3	17
Cinnamon, whole	......	......	......	1	......	1
Cinnamon, ground	4	1	3	22	......	22
Cassia	2	1	1	...	......	......
Cayenne	4	1	3	14	1	13
Mustard	6	4	2	21	2	19
Vinegar	6	4	2	9	8	1
Pickles	1	1	......	......	......	......
Confectionery:						
Red	......	......	......	13	13	......
Yellow	......	......	......	5	1	4
	304	280	24	409	226	183

Percentage of condemned articles in A=7.89.
Percentage of condemned articles in Z=44.74.

APPENDIX.

In the tabulation of the examined articles the capital letters prefixed to their number indicate the source from which each specimen was obtained. Where the presumption of purity attaches to the source, as in the samples furnished by dealers who were aware of the object in collecting them, one or other of the initial letters of the alphabet is chosen; but where the presumption is in favor of adulteration, as in articles purchased in the poorer districts of this and other cities, with no knowledge on the part of the dealer of the object of the purchase, one or other of the terminal letters is used.

Thus A indicates that the specimens were furnished by the better class of dealers in Washington City;

B, that they were obtained by the Commissary-General of Subsistence, United States Army, from mills, factories, or wholesale firms;

C, that the samples came from the Paymaster-General of the Navy;

D, from the Chief Medical Purveyor, United States Army; and

E, from the Commissioner of Agriculture; while

W, were purchased in Washington City;

X, in Tennessee;

Y, in New York City; and

Z, in Baltimore, Md.

TEAS.

A little uncertainty was felt as to the best method of dealing with the teas, not so much for the detection of adulteration as for the grading of quality. In cases where the medicinal properties of a vegetable substance are dependent on the existence of an alkaloid the estimation of the active principle suffices to indicate the character and market value of the sample. But the alkaloid of tea does not constitute its only active principal. The volatile oil on which the aroma of the infusion depends is an important constituent. Moreover, the methods for the extraction of the alkaloid are uncertain, or some analysis must have met with very anomalous specimens, as the theine has been found to range from .43 per cent. in Mülder's analysis to 6.21 in Péligot's (quoted by Hassall).

Tannin is generally regarded as of importance, and most published analyses contain a statement of its amount. Before commencing operations on the following teas several

processes were tried for the estimation of the tannin, but by none of them could satisfactory results be obtained.

With the view of determining what processes were really of value in an investigation which was intended not only to detect the presence of foreign substances, but also the mixture of inferior with better grades of the genuine article, a series of experiments was instituted on each sample. The moisture was obtained by drying in an air-bath for twelve or fifteen hours at a temperature of 200–212° Fah. This loss of weight was required partly as showing a well or poorly preserved or prepared article, but chiefly that the other results, when obtained, might be made susceptible of comparison by reducing them to percentages of the dried tea. The ash, weight, and alkalinity of that part of it which was soluble in water and the weight of its siliceous residue were determined. The gum was precipitated from an extract by alcohol, dried, weighed in a weighed filter, the weight of its ash being deducted from the result. The extractive was obtained by a thorough exhaustion in the water-bath with successive waters. A similar infusion evaporated with magnesia and treated with ether for forty-eight hours was relied upon for the extraction of the alkaloid. The whole of the theine may not have been dissolved by this means, but as all the teas were treated by the same process the results necessarily have a comparative if not an absolute value.

In looking over the figures in the following tabular statements, it is found that the moisture varies from 2.70 in the Japans to 9.12 in the congous, the average being for the congous 8.09, the pekoes 6.41, the oolongs 6.82, the imperials 6.50, the gunpowders 5.98, the hysons 6.61, and the Japans 4.69 per cent.

From the manner in which the leaves are collected and prepared, it is manifest that a certain amount of sand and clay must be incorporated with the commercial article, which will increase the amount of ash and show itself again in the insoluble siliceous residue. But as oolong A 18 and Japan A 3 show on .13 and .16 per cent. of silica, it is evident that the quantity of this substance naturally present in the leaf must be very minute, and that any slight increase must be considered an accidental impurity, owing to carelessness in preparation, and probably corresponding with an inferiority in the market value of the leaves containing it. Some exceptions must be made to this inference, as sand and minute pebbles may be added to an otherwise superior article for the sake of the gain in weight, as appears to have been the case in gunpowder A 26 and 57. Where the silica is high, as in imperial W 2, there is no doubt as to the fraudulent character of its presence.

In general terms, where the silica is low, say under .50 per cent., we are dealing with a clean and probably superior article. Where it exceeds this amout, but is under 1 per cent., the specimen is an inferior tea carelessly prepared, or a good article willfully adulterated before shipment, as it can hardly be supposed that our home dealers would tamper with a fine article in this petty manner; and where it is present in large excess there is no doubt as to the fraudulent intention.

Corresponding with this excess in the silica is the excess of weight in the ash. O, the teas given below, those samples which have less than .50 per cent. of silica have an ash weighing on the average among the oolongs 6.29 and among the greens 6.20 per cent. The silica is so high among the congous, no doubt owing to exposure during fermentation, that none of them enter into this calculation. These figures may be viewed as representing the ash of good commercial articles. A slight increase over them corresponds with inferiority in quality, and a large increase, as in imperial W 2, with fraudulent admixture. On the other hand, exhausted leaves may correspond with a good showing in the ash and its residue, as seen in imperial Y 1.

The soluble ash, its alkalinity, and the quantity of theine are proportioned, generally speaking, to the quality of the sample, but there are so many exceptions, old leaves often showing higher figures than younger, higher priced, and evidently more carefully prepared specimens, that these determinations are deprived of much of their value.

The gum is so variable that nothing can be learned concerning the quality of the tea from its estimation. It is noticeable that this ingredient is high in the Japan teas.

The extractive varies from 25.8 among the congous to 46.6 per cent. among the gunpowders, the average being for congous 28.88, pekoes 37.75, oolongs 37.25, imperials 35.14, gunpowders 38.78, hysons 36.76, and Japans 39.41 per cent. Where the extractive falls below 20 per cent. in a congou, or 30 per cent. in any of the others, the probability of an admixture of exhausted leaves or other deteriorating substances is very great.

A. W. Blythe, in his Manual of Practical Chemistry, says that "the time is probably not far distant when the tea trade will buy entirely by analysis, supplemented in a few cases by a taster's report. An experienced palate will detect particular flavors which analysis may fail to show, but a fairly complete chemical examination of tea is of the highest value, whether as a guide to the purchase or merely to show its freedom from adulteration." The analyses given below fail to support this prediction. On the contrary it would appear that a careful examination of the general characters of the sample by one who has some experience to guide him will give better indications of quality and do as much for the detection of adulteration as the fairly complete

chemical analysis. The leaves of the different brands have distinct characteristics. Congous and oolongs are small and whole or larger and divided transversely, each piece being more or less carefully rolled or twisted. Gunpowders are small, young leaves, rolled into pellets; imperials, larger and older leaves, similarly rolled; hysons, elongated leaves, rolled into cylinders which are bent on themselves or rolled into loose pellets; Japans, rolled and twisted or compressed. The quality of the leaves is usually proportioned to the perfection of the rolling and the freedom of the sample from dust or broken fragments. Exhausted and redried leaves can be picked out by an expert and an extract made and weighed to corroborate the suspicion. It is probable that an estimation of the gum might be of value in this connection. When the leaves are unrolled by the action of boiling water foreign leaves can be detected and the value of the sample, if genuine, can be approximated according as it consists of young and perfect leaves, of fragments of older ones, of buds, of dust, or of woody petioles and midribs. Facing can be seen in the cloudiness of the infusion and in the pulverulent sediment, where sand and pebbles can also be detected if existing in quantities sufficient to indicate their fraudulent presence. The weight of the ash and of its silica will give expression to this adulteration.

The Japan teas (*a*) were sent from Yokohama by Dr. Thomas H. Street, U. S. N., to enable a comparison to be made with those in the markets of this country. A large consignment of specimens (178) has been received through the State Department from the consul-general at Shanghai. The principal varieties of Chinese growth are represented in this series, but they unfortunately did not arrive in time to permit of their examination in connection with this report.

The specimens sent by Commissioner Le Duc of the Agricultural Department were grown in Georgia. Their deficiency in gum is remarkable.

All the experiments were made on the moist article, but the figures recorded represent percentages of the dry tea. The alkalinity is expressed as anhydrous potassa.

CONGOUS.

	Moisture.	Ash.	Soluble ash.	Alkalinity.	Silica.	Gum.	Extractive.	Theine.	Price per pound.	Remarks.
A. 1	7.50	6.85	3.18	1.40	.54	5.51	25.8	1.54	$0 75	Leaves, ¾ to ½ inch, but mostly broken; some of the smaller whole; many petioles.
2	7.42	7.32	3.26	1.29	.62	5.40	26.3	1.40	1 00	Many fragments, but a large proportion of the leaves whole, 1½ inches long; many petioles.
3	9.12	7.04	3.12	1.33	.72	6.38	34.1	1.43	1 00	Leaves small and whole or large and divided.
4	8.00	7.78	3.04	1.25	1.56	6.63	28.4	1.55	60	None whole; all broken or divided transversely; many petioles.
5	8.48	6.47	3.39	1.48	.76	4.26	30.7	1.67	80	Leaves ¾ to 1½ inches; the smaller whole; the larger divided; many broken.
6	7.94	7.32	3.80	1.69	.87	4.89	30.9	......	90	Leaves young, but all divided into two or three pieces.
W. 1	8.76	6.97	......	......	.96	......	28.1	1.42	......	Much tea dust; no whole leaves; all divided originally, but broken into small fragments now.
2	7.48	7.54	2.66	1.42	1.51	6.16	26.7	1.84	......	

PEKOES.

E. 1	7.36	6.24	3.20	1.29	.63	1.10	34.6	1.43	......	Marked "Broken Pekoe." Fragments of small young leaves.
2	5.46	6.09	2.88	1.43	.30	.95	32.9	1.20	......	Marked "Pekoe Souchong." Leaves divided; a few whole, ¾ to 1½ inches long.

OOLONGS.

A. 1	5.16	5.97	3.79	1.40	.45	5.69	33.2	1.61	0 50	All in fragments; when whole, 1½ to 2½ inches; many petioles.
2	6.43	6.41	3.44	1.31	.19	5.56	36.3	1.92	1 25	"Foochow." Leaves divided; many whole, 1½ inches.
3	6.85	6.97	3.28	1.28	.43	6.76	33.4	1.82	70	Many large leaves whole and many leaf-stalks.

OOLONGS—Continued.

	Moisture.	Ash.	Soluble ash.	Alkalinity.	Silica.	Gum.	Extractive.	Theine.	Price per pound.	Remarks.
4	6.60	6.77	3.17	1.37	.85	6.85	36.7	1.45	1 00	Broken, but the whole leaves small and young.
5	6.48	6.24	......	......	.38	......	......	1.68	60	Leaves nearly all broken.
6	6.20	6.30	......	......	.43	......	......	1.38	50	Mostly whole, large, old, leathery, and with woody petioles.
7	6.50	6.45	......	......	.43	......	......	1.31	50	Leaves large and broken; a few small ones whole; many woody petioles.
8	6.42	5.93	3.84	1.62	.38	10.00	36.8	......	80	Large leaves, 1¼ to 2½ inches, mostly whole; midribs and leaf-stalks tender.
9	6.00	7.02	3.62	1.60	.91	2.34	34.3	1.28	1 00	Leaves mostly whole; some petioles and twigs.
10	6.60	6.79	......	......	.48	......	......	1.42	75	Mixed leaves, large and small; all more or less broken, and many petioles.
11	6.30	6.40	......	......	.77	......	......	1.46	50	A few large whole leaves and much tea dust.
12	6.92	5.97	......	......	.43	......	......	1.79	90	"Formosa." Leaves whole or cut transversely; many petioles but all soft, and little dust.
13	6.76	6.15	......	......	.77	7.72	39.4	......	75	Leaves ¾ to 1½ inches; the smaller whole, the larger divided.
14	7.30	5.66	......	......	.48	8.74	41.6	......	1 00	Leaves ¾ to 1¼ inches, mostly whole; many soft petioles.
15	2.24	6.14	......	......	1.02	9.10	36.8	......	50	Leaves 1 to 1¾ inches; many petioles; wiry.
16	7.34	6.30	3.23	1.14	.53	12.80	39.4	......	1 00	Mostly whole or divided; few fragments.
17	7.40	7.71	2.74	1.39	.97	10.05	33.8	......	50	Ash is properly 6.26 per cent., as a small piece of quartz, weighing .072 grams, was found in the 5 grams ignited.
18	7.48	6.14	......	......	.13	8.00	44.0	1.34	1 00	Leaves mostly whole; some divided; ¾ to 1½ inches.
19	7.64	6.43	......	......	.58	4.98	40.0	1.13	50	Leaves ¾ to 1½ inches; smaller whole, larger divided; many petioles.
20	7.62	6.50	3.68	1.69	.43	13.00	37.0	......	50	Leaves 1¼ to 2¼ inches; many broken; much woody tissue in petioles and midribs.
21	7.89	6.08	3.06	1.49	.43	7.16	38.5	......	50	Leaves old and woody; large and whole, or divided.
22	8.26	6.76	3.40	1.24	.48	6.32	37.2	......	90	Leaves 1 to 2 inches; many whole; some divided or broken; petioles soft.
23	7.36	6.26	3.22	1.50	.43	11.50	39.6	......	50	As the last, but petioles and midribs hard.
24	7.36	5.90	3.61	1.50	.43	6.70	37.4	......	50	Mostly fragments of old and tough leaves.
25	6.60	6.32	3.73	1.56	.32	6.64	36.6	......	75	Leaves mostly whole; 1 to 2¼ inches; some of the larger divided.
26	8.66	6.50	3.17	1.41	.68	11.60	36.9	1.40	33	As the last, but with many fragments and woody petioles.
27	7.04	6.58	3.25	1.53	.56	6.56	35.2	......	50	Many whole leaves; some fragments and petioles.
28	7.34	6.62	3.62	1.50	.49	8.42	37.7	......	75	Leaves 1 to 1¼ inches; mostly divided; some very broad.
29	5.80	6.07	3.91	1.63	.55	8.92	38.0	......	50	Leaves 1 to 1½ inches, divided; a few woody petioles; manganese largely present in the ash of this sample.
W. 1	7.20	5.82	3.02	1.51	.54	......	37.4	......	......	Leaves ¾ to 1¼; mostly cut; but some whole; few fragments; petioles soft.
2	7.08	6.25	3.49	1.70	.60	......	35.7	......	......	Leaves divided; woody midribs, and many petioles.
3	6.84	6.31	......	1.35	1.12	......	33.8	......	......	Leaves large and elongated; tough and woody midribs, and many petioles.
4	6.90	6.27	......	1.59	.97	......	35.3	......	......	Mostly fragments of large leaves; woody petioles.
D. 1	6.42	6.26	3.86	1.49	.43	3.42	42.1	1.68	......	Leaves large and old; mostly whole; few fragments; much manganese present.
C. 1	7.58	6.53	4.09	1.86	.61	7.90	34.0	1.51	......	Leaves large and divided; edges frayed; many petioles and buds; much manganese present.

GUNPOWDERS.

	Moisture.	Ash.	Soluble ash.	Alkalinity.	Silica.	Gum.	Extractive.	Theine.	Price per pound.	Remarks.
A. 1	5.28	7.14	4.16	1.75	.21	7.60	37.1	2.11	$1 40	Leaves ¾ to 1½ inches; young, and some broken.
2	4.72	6.72	3.88	1.90	1.09	3.86	32.9	1.26	50	Leaves divided; 1¼ to 1¾ inches, whole and broken; many petioles, and small fragments of charcoal.
3	5.10	6.79	..	......	.42	....	.	1.30	1 00	Many leaves broken; medium in size.
4	4.36	7.99	3.78	1.74	.58	8.26	38.9	.94	70	Leaves young, but much broken.
5	5.84	5.35	3.76	1.68	.27	7.11	38.2	1.06	99	No whole leaves; fragments of medium-sized leaves.
6	6.16	6.99	......	......	.55	......	......	1.31	1 20	Leaves ¾ to ½ inch, largely divided, small whole, no *débris*.
7	6.04	6.69	......	......	.57	......	......	2.02	1 00	Leaves small, ¾ inch, many broken.
8	5.40	7.66	3.43	1.43	.53	5.92	33.5	1.34	50	Mostly broken fragments of large leaves.
9	5.48	6.42	......	......	.44	......	......	1.69	1 25	Leaves small and whole; some larger ones broken.
10	5.50	6.25	......	... ..	.40	6.56	42.3	......	......	Leaves young, 1 to 1½ inches; many broken.
11	5.36	7.44	3.34	1.33	1.31	6.66	34.6	......	50	Leaves large and divided.
12	6.84	7.60	......	......	.81	8.04	44.7	......	1 20	Leaves small; generally whole.
13	7.04	7.16	......		1.10	5.38	42.4	.....	1 20	All fragments of medium leaves.
14	5.45	6.81	4.19	1.64	.48	14.60	33.8	......	1 25	Leaves mostly small and whole.
15	6.24	6.76	3.94	1.76	.38	6.29	46.1	....	1 20	Medium-sized leaves, mostly divided.
16	5.40	7.96	3.53	1.49	1.29	6.66	34.8	......	50	Fragments of large leaves.
17	5.84	7.52	3.63	1.55	1.12	10.19	38.8	......	80	Broken pieces of medium leaves.
18	5.30	6.66	3.85	1.51	.65	10.15	37.4	......	1 25	Leaves small and young; mostly whole.
19	7.72	6.48	3.64	1.43	.91	6.61	36.3	.....	40	Fragments of old large leaves; dead flies.
20	6.10	7.41	3.92	1.52	1.06	10.80	44.6	.....	1 00	Small leaves whole, but with some fragments of larger and older leaves.
21	7.30	6.54	3.76	1.62	......	11.44	43.1	.....	75	Fragments of large leaves.
22	6.50	6.46	3.46	1.44	......	9.62	38.4	......	50	Pieces of large old leaves, with some smaller and whole.
23	6.48	7.36	3.42	1.44	......	12.30	41.9	....	75	Leaves 1 to 1½ inches, mostly whole.
24	6.80	6.76	3.88	1.59	......	8.90	43.7	......	1 00	Small whole leaves, with some fragments of old leaves.
25	6.64	6.58	3.94	1.71	.43	10.90	43.1	......	1 00	Leaves ¾ to 1½ inches; many broken, but no mixing.
26	6.42	8.63	3.52	1.43	1.84	12.10	46.0	......	1 25	Leaves small; generally whole; quartz pebbles size of pin-head in the ash.
27	5.32	7.46	4.16	1.66	1.06	11.63	43.7	......	1 10	Leaves small, generally whole; but some larger ones and pebbles, as in last.
28	4.56	6.81	3.77	1.65	.61	7.86	43.9	......	1 25	Leaves small, but many larger divided; all young.
29	6.34	7.49	3.02	1.39	1.81	10.35	46.6	......	1 25	Five grams contained a fragment of iron weighing 50 milligrams and some quartz pebbles. Leaves small and young.
Y. 1	6.96	7.63	3.03	1.28	.67	7.06	32.4	.....	......	Small fragments of old leaves, very coarsely faced.
2	6.90	9.23	3.00	1.28	.94	4.83	34.7	......	......	

IMPERIALS.

	Moisture.	Ash.	Soluble ash.	Alkalinity.	Silica.	Gum.	Extractive.	Theine.	Price per pound.	Remarks.
A. 1	5.44	5.88	3.74	1.58	.30	6.56	35.1	1.59	1 00	Leaves large and mostly whole.
2	5.02	6.19	3.51	1.37	.27	7.58	34.2	1.79	1 25	Leaves ¾ to 1½ inches, mostly whole; a few petioles.
3	5.32	7.06	....	......	.59	....	.....	1.37	75	Leaves large and whole; some very large, 2½ inches, divided.
4	5.94	8.12	3.86	1.31	1.33	7.02	31.3	1.24	50	Leaves old and mostly in large fragments.
5	6.54	7.72	3.19	1.83	1.09	4.92	33.5	......	50	Small leaves; large ones divided, and fragments.
6	5.94	6.06	3.19	1.49	.34	6.91	36.1	.....	80	Leaves 1½ to 2½ inches; some very broad, 1½ inches; many divided.
7	5.64	6.32	3.54	1.61	.30	9.43	36.9	1.62	50	Leaves old, 2½ inches many fragments.
8	6.75	6.05	3.49	1.61	.45	9.22	40.1	.....	75	Large, broad leaves, whole and divided.
9	8.42	7.29	3.08	1.38	.70	8.08	32.5	1.17	33	A few whole large old frayed leaves, but much dust, and 5 per cent. flower-buds.
10	6.82	4.98	2.40	1.22	.21	9.12	30.9	1.39	50	Fragments of large old leaves.
11	6.69	6.33	3.21	1.49	.34	12.00	39.9	1.28	75	Mostly whole, 1½ to 2¼ inches.

IMPERIALS—Continued.

	Moisture.	Ash.	Soluble ash.	Alkalinity.	Silica.	Gum.	Extractive.	Theine.	Price per pound.	Remarks.
A. 12	7.90	6.04	3.32	1.55	.43	5.86	37.2	......	50	Large and woody, some appearing 3 inches long when the fragments are pieced.
W. 1	6.88	7.70	2.85	1.20	1.24	....	33.0	......	60	Leaves large and broad, mostly divided.
2	5.50	13.21	2.33	1.00	6.35	6.35	33.0	1.13	......	A few large leaves, but mostly dust, pebbles, and buds.
X. 1	7.24	6.47	3.12	1.39	.75	8.73	34.8	......	.....	Leaves from 1½ inches upward; the larger divided.
2	6.40	6.17	3.20	1.45	.47	4.80	38.6	......	......	
Y. 1	7.62	6.23	2.75	1.18	.39	3.25	15.4	......	.....	Fragments of large eroded leaves; many imperfectly rolled, and apparently exhausted and redried. In the statement given above of the average extractive of imperials, these three specimens were excluded.
2	6.65	6.00	3.25	1.54	.38	7.60	26.3	......	......	
3	6.96	6.51	2.90	1.45	.26	2.90	29.3	......	......	

HYSONS.

	Moisture.	Ash.	Soluble ash.	Alkalinity.	Silica.	Gum.	Extractive.	Theine.	Price per pound.	Remarks.
A. 1	6.40	6.71	4.06	1.71	.19	4.68	36.9	2.00	$1 00	Leaves cut transversely; medium in size.
2	6.54	5.82	3.14	1.58	.41	9.63	33.4	1.25	50	Large whole leaves; some broad, coarse-veined, and old.
3	5.58	6.56	......	......	.32	....	......	1.69	......	Leaves 1 to 1½ inches; many divided; some fragments and petioles.
4	6.86	6.14	3.00	1.31	.32	4.18	34.3	......	75	Large and mostly whole.
5	7.97	6.47	3.13	1.30	.69	10.53	34.7	1.52	30	Leaves very large, with wooded petioles and mid-veins.
6	6.22	5.50	3.58	1.52	.53	....	40.4	....	40	Leaves elongated, divided, and many broken.
7	5.90	6.67	....	......	1.00	....	43.0	......	50	
W. 1	7.18	5.94	3.33	1.62	.36	....	37.1	......	.....	Leaves large, divided, woody, and with eroded margins.
2	7.20	6.37	.....	......	.40	....	35.0	......	......	
3	6.26	7.15	......	1.68	1.00	....	36.0	......	......	

JAPANS.

	Moisture.	Ash.	Soluble ash.	Alkalinity.	Silica.	Gum.	Extractive.	Theine.	Price per pound.	Remarks.
A. 1	6.00	6.17	3.87	1.70	.23	6.06	39.9	1.91	$1 00	Leaves small and young, divided; many short-cut tender petioles.
2	5.92	7.13	......	......	.60	....	......	1.35	50	Leaves small, fragments; old; compressed, rather than rolled.
3	7.90	5.57	3.24	1.43	.16	9.00	37.7	.98	1 00	Leaves large and broken; many petioles, but tender.
4	7.14	6.44	......	......	.60	12.30	37.0	......	50	All in small fragments; compressed.
5	5.76	7.32	3.82	1.27	1.27	11.24	40.9	1.27	60	
W. 1	5.00	7.64	3.26	1.39	1.47	5.79	35.0	1.34	......	
(a) 1	2.86	7.00	2.78	1.40	1.20	12.50	35.0	1.17	.....	Leaves divided and broken; margins often eroded; petioles wiry. Marked "*Good Common, $19 per picul.*"
2	2.70	7.24	2.60	1.40	1.26	11.10	37.9	1.07	......	As last, but less erosion. Marked "*Medium, $23 per picul.*"
3	2.82	6.68	2.92	1.40	1.04	10.00	40.0	1.25	......	As last, but some small and whole among them; the greater portion, however, still large, and often broad fragments with wiry petioles and mid-veins. Marked "*Good Medium, $25 per picul.*"
4	2.70	6.28	3.16	1.40	.64	10.50	42.0	1.47	......	Leaves 1½, but all broken or divided Marked "*Fine, $28 per picul.*"
5	3.92	5.78	3.06	1.36	.52	10.00	44.2	1.70	......	Leaves generally about 1 inch; many tender petioles. Marked "*Finest, $39 per picul.*"
6	3.54	5.53	3.10	1.32	.46	14.80	43.9	1.70	.....	Leaves generally about ¾ inch; many short-cut petioles. Marked "*Choicest, $43 per picul.*"

GROUND COFFEE.

Reliance was placed on the microscope for the detection of foreign vegetable substances in the ground coffee, and on the weight of the ash and silica for the discovery

of mineral additions. The silica present in clean coffee is almost *nil*. The admixture of chicory increases the amount of this residue on account of the higher percentage which it contains; but the silica may be increased in the absence of vegetable adulterants by mineral matter accidentally present among the coffee-beans. Its presence naturally indicates that the coffee has been ground from a low-grade, carelessly-picked stock, as seems to have been the case in several of the samples in series W. Excluding such specimens, the average ash of the pure coffees tabulated below is 4.15 per cent., the extremes varying but little from this mean.

The specific gravity of a 10 per cent. infusion, as suggested by Graham and others, was taken with the view of determining its reliability, as the experiment can be made more rapidly than a determination of the total extractive. The flask or covered beaker containing the coffee and water was immersed for an hour in the water-bath, which was kept boiling vigorously. The infusion was filtered, cooled to the proper temperature, and loss from evaporation made up by distilled water. The specific gravities obtained are rather lower than those recorded by Allen, due no doubt to a less perfect exhaustion than he effected. The amount of extractive corresponding to these specific gravities was ascertained and recorded. But it is believed that the thorough exhaustion of the coffee by means of successive waters and the estimation of the total extractive is a more satisfactory procedure than the method by density.

The soluble matters yielded by the unadulterated coffees averaged 21.2 per cent. Professor Parkes placed the yield at 30–35 per cent., and other writers make it equally high. The amount is said to depend on the degree of roasting. According to Hassall, Cadet states that coffee roasted to a red-brown color yields 12.3 per cent., chestnut-brown coffee 18.5 per cent., and dark brown 23.7 per cent. of extractive. This agrees with the results which are given below.

To establish the fact of adulteration in coffee, however, a simple inspection of the coffee-grounds after infusion is all that is needful. The coffee fragments retain a certain firmness of texture and darkness of color, while chicory, beans, and other vegetable matters become soft and whitish. These substances, as is well known, can also be separated by the rapidity of their fall when the coffee is thrown on the surface of a glass of cold water.

All the samples examined were loose coffees, with the exception of Z 1, which was in a one-pound packet.

GROUND COFFEE.

		Moisture.	Ash.	Silica.	Specific gravity.	Extractive.	Total extractive.	Remarks.
A	1	5.34	4.36	......	1007.2	17.8	....	
	2	5.26	4.70	......	1006.7	16.0	....	
	3	4.70	5.30	......	1007.1	17.7	....	
	4	4.50	4.10	......	1007.1	17.6	....	
W	1	4.44	4.40	......	1006.5	15.6	....	
	2	4.23	4.06	.08	1007.3	17.3	21.8	
	3	3.80	4.12	.04	1006.8	16.7	20.0	
	4	4.50	4.00	.04	1006.7	16.0	20.3	
	5	5.52	4.16	.04	1006.7	16.0	20.0	
	6	7.44	4.32	.08	1007.2	17.2	20.3	
	7	4.74	4.78	.60	1006.3	15.1	20.7	
	8	6.14	5.74	1.24	1006.0	15.0	20.2	Pure.
	9	7.40	5.10	.66	1006.0	15.0	20.4	
	10	6.10	5.82	1.06	1006.8	16.8	20.8	
	11	5.54	6.00	1.64	1006.2	15.1	20.2	
	12	4.78	5.14	.74	1006.8	16.8	19.6	
X	1	7.56	4.36	.02	1006.6	16.0	20.3	
Y	1	4.74	4.34	.32	1007.4	18.5	22.2	
	2	5.50	4.14	.12	1007.3	17.5	22.0	
	3	4.00	4.00	.04	1006.6	16.1	21.8	
	4	6.16	4.20	.16	1007.0	17.1	24.0	
	5	3.16	4.16	.06	1007.2	18.2	22.1	
	6	5.36	4.30	.62	1011.0	28.0	42.3	Chicory and beans.
	7	5.52	4.44	.46	1011.4	28.2	40.2	
	8	4.24	4.24	.06	1006.9	16.8	22.3	
	9	4.24	4.14	.04	1006.8	16.9	32.0	Pure.
	10	4.42	4.16	.08	1006.6	16.1	23.1	
	11	3.92	5.80	.34	1008.2	21.1	22.5	Small per cent. chicory.
Z	1	......	1.80	.08	....	......	45.7	Chicory, corn, wheat, rye—anything but coffee.
C	1	5.64	4.02	.00	1007.2	17.3	20.7	Pure.

The last sample was also examined in the green or unroasted condition. The percentages were of moisture 8.80, ash 3.48, silica .00, and extractive 23.7. The coffee

extracts and two chicories were purchased in Baltimore. Their examination resulted as follows:

	Ash.	Silica.	Extractive.	Vegetable refuse.	Remarks.
Z. Extract 1	4.50	.04	71.0	24.5	Chiefly masses of disorganized starches.
2	6.90	1.00	68.0	25.1	Fresh wheat and débris of roasted starches.
3	7.10	2.68	69.0	28.9	Chicory.
Z. Chicory 1	7.66	2.80	60.0	32.3	Pure.
1	11.00	3.20	51.0	38.0	Pure.

SUGARS.

In investigating the sugars a solution was made in order to note insoluble impurities. After standing for some time the sediment, if any, was transferred to the stage of the microscope for examination. Most of the specimens showed the presence of accidental dust, such as may be found in the air of the grocery stores—starches of various kinds, tea and coffee particles, &c. But unless existing in quantity sufficient to impair the transparency of the solution, these could not be considered as detracting from the value of the sugar. The moisture in the sample was taken by drying 5 grams in an air-chamber for 12 or 15 hours at a temperature from 200° to 212° Fahr. The ash was obtained by igniting 15 grams over a composite Bunsen flame. The last of the carbon is dissipated with difficulty, especially in dark-colored sugars, and the results are therefore only approximative; but the main object in reducing to an ash was the detection of tin or copper, or of excessive quantities of iron or lime.

The detection of glucose or starch sugar is easily effected in the white sugars—the loaf, crushed, powdered, and granulated—as these contain so small a quantity of transformed cane sugar. The process adopted for the estimation of the glucose consisted of adding a weighed quantity of the sugar in solution to an excess of Fehling's solution heated to boiling on the water-bath. In a short time, when the reduction was accomplished, the blue liquid was poured off and the precipitate washed with boiling water by decantation. Filtration was seldom needful. The precipitate was then solved in ferric chloride with a little diluted sulphuric acid, cold water added in large quantity, and the estimation made by permanganate of potash. But the brown sugars contain naturally a certain percentage of sugar which acts upon the copper solution. This percentage varies with the depth of color of the specimen. Experience, however, will soon enable one to pronounce from the color the amount of so-called grape sugar which is normal to it, and any excess found by experiment suggests the presence of added glucose. In fact, any excess over 6 per cent. is suspicious, unless the sample is very dark. I regret that specimens of the Dutch standard were not available for the identification of the shades of the examined sugars. Even 6 per cent. may give grounds for suspicion in light-colored samples. Fortunately we have in the microscope a means for decision in uncertain cases. Microscopic masses of boiled starch cannot be accounted for in the sediment of the sugar solution, unless by assuming the incorporation of manufactured glucose with the sample. Any excess in the percentage of glucose found should therefore lead to a careful search for these tell-tale masses of disorganized starch. It has been stated as an argument against adulteration by glucose that the profit on the addition of small percentages would not pay for the expense of mixing, but several instances, such as W 1, Y 10, and Z 4 and 10, show conclusively that the mixing has been done. Where the glucose results are as high as in A 4 and 18, W 4, 5, 6, and 12, and Z 3, there is no need for corroboration of the microscope. Indeed such sugars may be recognized by simple inspection. They are characterized by their want of luster, and by caking into masses which have a waxy fracture. It is probable that A 3 contains glucose, although the starch cells were not observed. This was one of the first specimens examined, and, as its color was very dark, the percentage of glucose was accepted as owing to the large quantity of molasses present; but, as subsequent experiments showed the glucose in the specimen to be higher than the average in sugars of its color, it is probable that a more careful microscopic examination might have detected the starch.

The samples marked *a* were presented by the Forest City Refinery, of Portland, Me.

LOAF SUGAR.

		Moisture.	Ash.	Grape sugar.	Remarks.
W	1	.10	.02	.010	Sediment *nil.*
	2	.03	.00	.030	

CRUSHED SUGAR.

W	1	.20	.00	.04	Sediment *nil.*

POWDERED SUGAR.

A	1	.06	.00	.010	Accidental starch.
	2	....	......	.062	*Nil.*
	3	.12	.04	.062	Starch and cane fragments.
	4	....	......	.020	Accidental dust and starch.
	5	....	......	.055	*Nil.*
	6	....	......	.017	
	7	....	......	.017	Accidental corn-starch.
	8	....	......	.096	*Nil.*
W	1	.27	.04	.010	Accidental dust, chiefly corn-starch.
	2	.01	.01	.110	
	3	.12	.04	.043	
	4	.14	.04	.070	
	5	.04	.00	.040	
	6	.04	.00	.004	
	7	.04	.00	.004	*Nil.*
	8	.04	.00	.010	
	9	.04	.00	.008	
	10	.06	.00	.004	

GRANULATED SUGAR.

[illegible]	1	.04	.00	.078	*Nil.* Marked first quality.
	2	.17	.04	.183	*Nil.* Marked second quality.
A	1	.20	.00	.060	*Nil.*
	2	.00	.00	.120	Accidental dust.
	3	.00	.00	.040	Dust and cane particles.
	4	....	......	.030	
	5	....	......	.020	Accidental dust.
	6	....	......	.020	
	7	....	......	.030	
	8	....	......	.072	*Nil.*
	9	....	......	.144	Accidental dust.
	10	....	......	.038	
	11	....	......	.036	
	12	....	......	.017	*Nil.*
	13	.06	.00	.104	
	14	....	......	.130	
W	1	.03	.01	.050	Accidental dust.
	2	.14	.02	.130	

STANDARD A SUGARS.

[illegible]	1	1.80	.00	.060	*Nil.* Marked Standard A.
	2	2.40	.06	.261	*Nil.* Marked Falmouth A.
A	1	.36	.02	.520	
	2	.46	.20	.510	Dust and cane particles.
	3	.46	.32	.620	
	4	.40	.12	.720	
	5	1.52	.07	.375	*Nil.*
	6	.36	.00	.130	
W	1	1.17	.20	.378	Dust.

STANDARD C SUGARS.

A	1	4.50	2.48	6.74	Dust, coffee, &c.
	2	1.64	1.18	2.97	Cane, corn-starch, and bone phosphate.
	3	2.64	2.96	3.47	Accidental starches, &c.
	4	2.64	.55	4.96	
	5	[illegible]	.80	2.82	Bone phosphate.
B	1	1.54	.44	2.06	
	2	2.30	.90	4.20	Accidental dust.
	3	2.64	1.40	4.00	
	4	2.10	[illegible]	2.32	

VARIOUS SUGARS.

		Moisture.	Ash.	Grape sugar.	Remarks.
A	1	3.70	1.82	7.32	Accidental dust............ Brown, 9 cents.
	2	3.70	1.50	5.23	Brown, 10 cents.
	3	4.14	1.92	9.10	Brown, 9 cents.
	4	3.86	.60	20.00	Torula, disorganized starch cells and cane particles; N. P. B., 9½ cents.
	5	.26	.06	.18	Accidental dust............ 2d A, 10½ cents.
	6	3.50	1.76	6.36	Ex. C, 9 cents.
	7	1.34	1.08	1.54	.30 per cent. insoluble, of which .07 is organic and the rest bone phosphate. N. O., 9 cents.
	8	2.22	1.12	3.43	Brown, 9 cents.
	9	.88	.68	2.85	Dust.
	10	4.30	2.40	6.61	*Nil*............ Brown, 9 cents.
	11	.92	.38	3.10	Wheat-starch and torula cells............ Brown, 9 cents.
	12	4.24	3.38	3.15	Cane fragments, sand and acarus............ D. B., 8½ cents.
	13	4.30	1.86	6.48	Corn-starch............ Brown, 9 cents.
	14	2.84	1.78	6.40	Dust............ Brown, 9 cents.
	15	2.06	.35	.85	*Nil*............ L. B., 10 cents.
	16	5.52	1.15	5.45	Dust............ Brown, 9 cents.
	17	.40	.37	.46	*Nil*............ N. O. Vac., 10 cents.
	18	4.00	.30	14.00	Disorganized corn-starch and torula; brown, 10 cents, special.
	19	3.88	.33	3.40	Dust............ Brown, 10 cents.
	20	4.26	1.25	3.35	*Nil*............ Brown, 9 cents.
	21	4.72	.42	4.71	*Nil*............ Brown, 10 cents.
	22	4.76	1.13	4.00	Brown, 10 cents.
	23	2.61	.25	1.49	Brown, 10 cents.
B	1	.60	1.24	1.56	*Nil.*
	2	1.26	.52	3.50	
	3	1.34	.74	2.60	
	4	.90	.44	3.70	
C	1	1.68	.37	1.24	*Nil.*
E	1	3.80	.23	3.70	"Corn-stalk sugar," Made in Georgia.
	2	2.73	.33	5.35	"Sorghum sugar," Made in Georgia.
W	1	5.00	.97	8.77	Masses of disorganized corn-starch.
	2	5.82	.88	4.97	Accidental dust.
	3	3.78	.48	3.32	
	4	5.76	3.07	13.50	Boiled corn-starch.
	5	4.88	.44	20.00	
	6	5.16	.44	20.00	Corn-starch and acarus.
	7	7.56	.66	5.60	Accidental dust.
	8	4.30	.66	4.00	
	9	6.10	.78	4.97	
	10	2.76	.54	4.55	*Nil.*
	11	3.96	1.04	5.00	.058 per cent. lime.
	12	4.80	.74	18.50	Boiled corn-starch.
	13	5.04	.32	3.20	*Nil.* .060 per cent. lime.
	14	4.06	.90	3.12	Accidental flour.
X	1	1.44	1.04	2.52	*Nil.*
	2	1.20	.44	1.94	Bone phosphate and vast numbers of acarus.
	3	3.14	2.44	6.72	Accidental flour.
Y	1	1.88	.43	2.70	*Nil.*
	2	3.56	.51	4.00	
	3	3.44	.58	3.50	
	4	3.20	.62	5.80	
	5	2.84	.75	4.30	
	6	4.36	.81	6.50	
	7	2.90	.60	3.60	
	8	3.92	.83	5.20	
	9	2.30	.50	4.30	*Nil.*
	10	4.64	1.45	10.00	Disorganized corn-starch.
Z	1	1.08	.66	5.00	Accidental dust.
	2	1.66	.45	2.50	*Nil.*
	3	3.90	1.07	31.00	Disorganized wheat-flour.
	4	3.44	1.50	11.50	
	5	1.24	1.05	3.40	Accidental dust, wheat-starch, and black pepper.
	6	2.44	.90	6.00	
	7	2.60	1.30	6.70	
	8	2.66	1.82	6.40	
	9	2.36	1.02	6.20	*Nil.*
	10	2.30	1.30	8.40	Disorganized corn-starch.

SIRUPS.

The moisture, ash, and glucose were obtained as in the case of the sugars. On account of the large quantity of reducing sugar naturally present in sirup and molasses it would be a difficult matter to detect the presence of a small addition of glucose solution unless the disorganized starch corpuscles were discovered on microscopic examination. But any large addition would manifest its presence by the unusual quantity of reducing sugar found by experiment.

To ascertain the quantity of so-called grape sugar naturally present in the sirups, four samples B were obtained from refiners by the Commissary-General of Subsistence, United States Army. The specimens furnished by Washington dealers were also viewed as representing the ordinary character of unadulterated sirups, since it was unlikely that any which were known to contain manufactured glucose would be sent in for analysis. These gave varying percentages up to 29.60, while the largest figure obtained from any of the examined sirups was only 35.30 per cent. Taken in conjunction with their freedom from starch corpuscles, it seems clear that in none was there any addition of manufactured glucose. The results correspond with those obtained by Wallace from the products of a Greenock sugar refinery. His analysis, as quoted by Hassall, are:

	Moisture.	Ash.	Grape sugar.	Coloring and extractive.	Cane sugar.
Golden sirup	22.7	2.5	33.00	2.8	39.6
Molasses	31.1	1.4	18.00	1.5	48.0
Treacle	23.4	3.5	37.20	3.5	32.5

The following analyses are so much at variance with Professor Kedzie's results, recorded in the Michigan State Board of Health Report for 1874, that it is difficult to reconcile them except on the assumption that at that time the market was stocked with a manufactured article which failed to please the public taste and has since disappeared. His specimens, which were all obtained from first-class grocers, are offset in the following list by twenty-one samples from first-class sources and twelve from the lowest grade stores which could be found in Washington City:

SIRUPS.

		Marks.	Price.	Moisture.	Ash.	Grape sugar.	Remarks.
			Cents.				
A	1	Molasses	40	21.00	3.48	25.90	
	2	do	60	16.36	.84	22.80	Sediment. *Nil.*
	3	do	50	17.20	1.30	23.12	
	4	do	50	28.71	2.55	12.26	Torula cells.
	5	Black strap	30	26.82	4.21	25.70	
	6	Porto Rico	75	25.23	1.04	19.24	
	7	Sirup	60	26.04	4.45	16.10	
	8	do		21.00	.70	22.30	
	9	Golden sirup	60	19.33	3.90	23.57	
	10	do	60	22.61	.53	21.10	
	11	do	60	23.21	2.22	26.71	*Nil.*
	12	do	60	21.05	1.92	29.60	
	13	Drip sirup	75	18.54	3.45	26.00	
	14	do	60	17.30	3.72	26.16	
	15	do	80	17.17	2.03	29.00	
	16	do	75	18.00	3.18	29.60	
B	1	Sirup		17.83	4.40	29.00	*Nil.*
	2	do		22.22	4.50	21.25	Lime, .112 per cent. *Nil.*
	3	do		24.90	3.49	21.40	*Nil.*
	4	do		19.10	3.40	20.42	*Nil.*
C	1	Molasses		19.00	4.72	21.00	
W	1	do		22.00	4.60	26.40	*Nil.*
	2	do		27.00	3.89	30.00	
	3	Sirup		27.00	2.38	17.00	Torula cells.
	4	do		16.00	.98	26.00	*Nil.*
	5	do		22.00	1.05	33.00	Lime, .187 per cent. *Nil.*
	6	do		26.00	2.25	31.40	Lime, .056 per cent. *Nil.*
	7	do		26.20	3.30	35.30	Lime, .19 per cent. *Nil.*
	8	do		27.80	1.66	35.10	*Nil.*
	9	do		21.30	.90	33.10	*Nil.*
	10	Muscovado		28.00	2.65	11.63	Bacteria, bacilli, and torula.
	11	Porto Rico		20.00	3.53	27.20	Lime, .07 per cent.
	12	Golden sirup		17.00	.92	29.00	Bacteria.

FLOUR.

The moisture was taken by drying in the air-chamber, and the gluten by washing **and drying as ordinarily practiced.** These estimations have a reference more to quality **than impurity.** The average moisture is 11.09 per cent., the maximum being 12.80 **and the minimum 8.20.**

The gluten varies considerably, from 7.40 in B 18 to 17.50 in B 23. The samples

represent the production of all parts of the country, those in series B having been obtained from military depots and posts through the kindness of the Commissary-General of the Army. They embrace winter and spring wheats, the strongest flour produced by high milling, straight flours by the same process and those produced by mixing deteriorated flours with a highly glutinous stock so as to render them salable and useful. Hence the variation in the quantity of gluten. It may be stated from the experience gained in gathering these percentages that the flour is inferior when the gluten is under 10 per cent., of good marketable character when from 10 to 12, and of high grade when over 12 per cent.

An inspection of the figures of the ash shows the absence of mineral additions. Alum was proved to be absent by the use of the logwood and carbonate of ammonia test, but in cases where the ash was comparatively high the silica was separated and the phosphate of alumina thrown down from 100 grams and weighed. The average ash is .525 per cent.

The microscopic examination proved the freedom of the samples from foreign flours and fungous growths. B 27 contained a small quantity of comparatively coarsely ground corn. This was first detected as minute horny particles in washing out the gluten. When their presence was known they could be discovered by the fingers in the dry flour. Their nature was demonstrated by the microscope. As they occurred in but small quantity and in an otherwise superior flour, their presence must be considered accidental. An effort was made to discover the method of their introduction, but without success. The miller who ground the flour insisted that the particles must be sand which had insinuated itself through the meshes of the sacks from an unswept railway car into which they had been packed for transportation. On reporting the analysis of B 18 it was ascertained that this flour had been tested practically by a board of Army officers and condemned as unfit for bread-making.

The only noteworthy point developed by the microscopic examination is that the starch granules of superior samples did not scatter so freely over the field, but remained bound up by the cellulose into globular and cylindrical masses.

FLOURS.

	Moisture.	Ash.	Gluten.	Remarks.
A 1	10.80	.44	15.78	
2	11.92	.50	10.90	
B 1	11.84	.52	13.24	
2	11.60	.48	11.16	
3	12.14	.44	14.50	
4	11.80	.54	15.80	
5	11.80	.60	13.26	
6	11.18	.44	14.14	
7	12.26	.66	10.06	
8	11.54	.50	14.16	
9	11.56	.70	15.64	Silica, .008 per cent.; phos. alumina, .005 per cent.
10	8.80	.50	9.68	
11	8.20	.56	16.30	
12	11.46	.36	10.68	
13	11.22	.42	10.62	
14	10.92	.42	10.24	
15	10.74	.58	9.98	
16	8.96	.60	10.54	
17	10.88	.60	10.90	
18	9.96	.54	7.40	
19	9.52	.54	11.34	
20	10.72	.60	8.34	
21	10.38	.70	8.70	Silica, .006 per cent.; phos. alumina, .005 per cent.
22	10.82	.46	10.78	
23	10.50	.60	17.50	
24	10.46	.60	10.12	
25	10.56	.46	13.70	
26	11.30	.60	13.04	
27	10.44	.50	14.30	
C 1	11.22	.50	13.66	
W 1	11.10	.56	10.76	
2	11.76	.38	10.60	
3	10.96	.52	11.54	
4	10.00	.56	10.98	
5	11.10	.48	14.46	
6	10.96	.48	11.14	
7	10.80	.50	12.30	
8	12.30	.54	11.72	
9	12.08	.60	13.08	
10	12.20	.52	9.72	
11	9.66	.56	11.88	
12	11.10	.46	10.66	
13	11.90	.46	10.76	
14	11.92	.50	11.12	
15	11.10	.46	10.72	

FLOURS—Continued.

	Moisture.	Ash.	Gluten.	Remarks.
W 16	10.00	.50	13.62	
17	12.02	.40	11.80	
18	11.60	.46	13.08	
19	11.28	.40	9.74	
20	9.54	.62	11.20	
21	9.56	.44	9.94	
X 1	12.20	.60	9.84	
2	12.66	.56	6.84	
Z 1	12.80	.50	11.60	
2	12.20	.78	8.40	Silica, .027 per cent.; alum. phosph., .006 per cent.
3	12.00	.58	9.50	
4	10.76	.54	12.66	
5	11.96	.54	11.96	

CORN-MEAL.

The moisture, ash, and microscopic appearances of these samples gave satisfactory proof of their freedom from impurities.

	Moisture.	Ash.	Remarks.
A 1	11.04	1.24	All free from foreign admixture.
2	10.49	1.28	
B 1	11.16	1.18	
2	10.92	1.34	
W 1	10.66	1.20	
2	11.54	1.20	
3	10.14	1.30	
4	10.34	1.32	
5	10.36	1.20	
6	11.14	1.24	
7	11.46	1.16	
8	12.00	1.16	
9	10.06	1.20	
10	11.06	1.24	
11	10.87	1.20	
12	11.50	1.16	
13	10.80	1.28	
14	10.80	1.28	
15	10.16	1.24	
16	10.64	1.32	
Average	10.85	1.24	

LARD.

A quantity varying from 12 to 20 grams was dried in the air-chamber and ignited. The results were so satisfactory that there seemed to be no necessity for adding to the number of samples.

	Ash.	Water.	Remarks.
W 1	.030	.03	No starch or other adulterant by the microscope.
2	.060	.21	
3	.000	.08	
4	.070	.07	
5	.020	.25	
6	.010	.14	
7	.010	.16	
8	.050	.15	
9	.020	.14	
10	.030	.10	
11	.025	.15	
12	.030	.00	
13	.013	.00	
14	.030	.01	
Average	.028	.107	

BREAD.

The breads were examined by the processes which were used in the case of the flours. They were all apparently of good quality, white, evenly vacuoled, and free from doughy

streaks. They were fresh at the time of the examination, but thoroughly cold. The crumb only was used. W 8 contains an excess of water, and quite a number have so much phosphate of alumina that the addition of alum is a certainty. J. Carter Bell in the *Analyst* for July, 1879, gives a series of illustrative cases showing that alumina may be present accidentally in flour and bread to a larger extent than is usually supposed, but that in such cases the proportion of the accompanying silica is also large, so that practically no difficulty is experienced in dealing with them. Those specimens in the following table which have a high phosphate of alumina do not have the silica correspondingly increased. The ash shows, as in the flour samples, that mineral powders are not much used as adulterants. Copper was not detected in any of the specimens.

	Moisture.	Ash.	Silica.	Phosphate of iron.	Phosphate of alumina.	Remarks.
W 1	6.34	1.06	.024	.0015	.009	Cream biscuits.
2	7.20	1.10	.024	.0013	.005	Soda biscuits.
3	30.80	.70	.052	.0013	.007	Rolls.
4	38.92	1.20	.036	.0027	.005	Loaf.
5	42.00	1.04	.012	.0013	.019	Do.
6	40.20	1.00	.012	.0000	.009	Do.
7	42.22	1.00	.020	.0015	.027	Do.
8	53.90	1.02	.016	.0027	.043	Do.
9	43.20	1.10	.015	.0009	.020	Do.
10	41.90	1.14	.009	.0013	.007	Do.
11	40.80	1.28	.015	.0009	.007	Do.
12	42.60	1.24	.024	.0007	.005	Do.
13	40.76	1.28	.016	.0015	.036	Do.
14	43.00	.96	.040	.0007	.006	Do.
15	40.80	1.08	.012	.0013	.020	Do.
16	42.74	1.24	.015	.0013	.030	Do.
17	45.70	1.08	.010	.0006	.005	Do.
18	43.90	.98	.010	.0027	.019	Do.
C 1	7.56	.58	.020	.0013	.005	Hard bread.

BICARBONATE OF SODA.

These samples were tested qualitatively for the presence of sulphur salts, chlorides, and sulphates. For the technical estimation of their value the weight of the ignited salt, its alkalinity, and the total of carbonic acid in the unignited specimen were considered necessary. Pure bicarbonate yields 63.1 per cent. of residue, and when the alkalinity is calculated into carbonate of soda the same figure should be obtained. Other results must of necessity be owing to impurity. Thus in W 1 the residue weighed 69.1, with an alkalinity showing 64.9 of carbonate of soda. There was therefore present 4.2 per cent. of mineral impurities, chiefly chlorides and sulphates. Again, pure bicarbonate contains 52.4 per cent. of carbonic acid. Any deficiency found in a particular case corresponds with non-carbonated impurity or with the presence of monocarbonate from careless manufacture or preservation. But as the former has already been obtained the latter can be calculated. The carbonic acid of the ash is deducted from the total carbonic acid for one-half of the amount existing as bicarbonate. The whole of the amount thus existing when deducted from the total gives that present as carbonate.

	Residue.	Alkalinity of residue.	Total carbonic acid.	Pure bicarb.	Carbonate.	Saline impurities.
A 1	64.9	63.6	49.2	=87.0	8.7	1.3
W 1	69.1	64.9	43.3	=62.6	25.3	4.2
2	65.1	61.7	47.6	=84.0	8.7	3.4
3	63.5	60.8	47.0	=83.2	8.2	2.7
4	64.3	62.0	50.6	=94.3	2.4	2.3
5	63.6	61.3	51.2	=97.0	0.0	2.3
6	65.4	61.8	48.6	=87.8	6.4	3.6
7	67.2	58.3	47.7	=89.7	1.7	8.9
8	64.5	62.1	50.6	=94.7	2.4	2.4
9	64.3	62.1	50.8	=95.5	1.9	2.2
10	67.6	57.5	47.1	=88.6	1.7	10.1
11	65.6	62.5	48.3	=89.0	4.1	2.6

BAKING-POWDERS.

In a baking-powder which, according to the qualitative analysis, consists of alum, bicarbonate, and starch, estimations of the alumina of the starch and of the excess, if any, of bicarbonate give all the data necessary to calculate its composition. In the case given below the carbonic and sulphuric acids were estimated to corroborate results.

In those whose essentials are bicarbonate and acid phosphate of lime, alumina, chlorine, and sulphuric acid may be discovered as impurities in the materials, the sulphates forming a considerable percentage. The lime, phosphoric and sulphuric acids were determined and the bicarbonate calculated from the chloride of sodium obtained from it, deduction being made for sodium salts existing as impurities.

In a third class of cases a mixture of alum and acid phosphate is found. With either of these acid salts, carbonic acid is evolved from bicarbonate, each molecule of alum setting free six of carbonic acid by means of its sulphuric acid, each molecule of phosphoric acid in excess of that rendered neutral by the lime acting in the same manner. But when the two are combined in one powder an interference takes place, and phosphoric acid falls with the alumina as insoluble phosphate without acting upon the bicarbonate. As alum is accused, and no doubt correctly, of precipitating the phosphates of the flour, the addition of the acid phosphate to the alum in these powders is probably intended to prevent this deterioration.

In powders which were proved by qualitative examination to consist of cream of tartar and bicarbonate, the excess of alkalinity was taken in the solution after thorough decomposition was accomplished, and was calculated into the bicarbonate existing in excess. The alkalinity of the ash with this excess deducted from it was a measure of the bicarbonate and pure cream of tartar present and of the carbonic acid evolved during decomposition. Starch had to be separated and weighed, The weight of the ignited powder afforded a check on the calculations. The cream of tartar in all the samples contained the proportion of lime tartrate usual in the commercial article. Some of the powders contained minute particles of woody tissue, which to the eye were suggestive of the presence of malt as a constituent, but the microscope developed their true character, while the absence of sugar by Fehling's solution gave chemical evidence of the non-existence of malt in the sample.

No tartaric acid powders were presented for examination.

	Bicarb. soda.	Bicarb. in excess.	Bitartrate.	Bitart. in excess.	Cryst. alum.	Lime sulphate.	Phosphoric acid existing as acid phosphate lime.	Starch.	Gum.	P. c. carbonic acid evolved.	Remarks.
W 1	26.6	......	......	......	48.0	......	......	51.9	......	13.9	
2	10.2	4.0	......	......	18.5	5.1	3.4	45.3	......	5.3	
3	10.2	4.0	......	......	18.5	1.0	3.4	38.5	......	5.3	
4	14.7	7.6	......	......	25.9	......	5.5	46.2	......	7.7	Corn-starch.
5	9.4	4.0	......	......	17.6	3.0	3.1	49.6	......	5.1	
6	31.0	......	......	......	......	10.9	19.3	22.0	......	16.0	
B 1	23.1	1.7	51.7	......	......	......	......	......	20.0	12.1	Spiral vessels, dotted ducts, &c., from impurities in the gum.
2	24.3	4.2	54.5	......	......	......	......	13.4	......	12.7	Wheat-starch.
3	7.8	......	17.4	4.4	......	......	......	55.5	......	4.1	Corn and wheat starches and woody tissue, suggesting malt.
4	21.4	4.7	47.9	......	......	......	......	12.6	......	11.2	Corn-starch.
5	15.2	1.5	34.1	......	......	......	......	36.2	......	8.0	Wheat and corn starch.
6	19.5	6.3	43.7	......	......	......	......	23.1	......	10.2	
7	26.8	1.8	60.2	......	......	......	......	6.0	......	14.1	
8	17.1	3.8	38.3	......	......	......	......	30.6	......	8.9	Corn-starch.
9	18.1	1.3	40.6	......	......	......	......	26.0	......	9.5	
10	18.2	2.3	40.8	......	......	......	......	31.2	......	9.5	
11	17.7	......	39.7	......	......	......	......	27.4	......	9.3	Corn-starch and wheat-flour.
12	16.8	5.9	37.7	......	......	......	......	29.2	......	8.8	Corn-starch.

CREAM OF TARTAR.

In the case of cream of tartar of ordinary commercial purity the alkalinity of the **ash gives the percentage** of pure bitartrate present, while that of the accompanying

lime tartrate may be deduced from an estimation of the lime. If terra alba has been added the sulphuric acid must also be determined. If an acid sulphate as of soda or potash is present the case becomes complicated, but it is probable that a comparison of the free acidity before ignition with the alkalinity existing after it would give valuable information concerning the percentages. In the case of a pure bitartrate the carbonate in the ash corresponds to the acidity of the sample, but in the presence of an acid sulphate the alkalinity of the ash would be diminished or perhaps destroyed. The precipitation of the acid as a baryta salt and its existence in excess of the lime would corroborate the result. A thorough examination of some of these adulterated samples involves a good deal of time and labor, and an accurate expression of the percentage of the pure article is sometimes only to be obtained with difficulty, but it seems as if all practical purposes would be effected by a simple determination of the lime or sulphuric acid, as neither terra alba, alum, acid, phosphate of lime, nor the acid sulphates of the alkalies can be present without giving percentages of one or other of those substances sufficient to detect adulteration and give expression to its amount. Starch can be discovered by iodine or the microscope.

		Bitartrate of potash.	Tartrate of lime.	Sulphate of lime.	Alum as crystallized.	Phosphoric acid in phosphate.	Starch.	Remarks.
A	1	87	8	....	....	....	....	
W	1	....	....	50	19	20	....	Amonia alum.
	2	84	8	....	....	....	....	
	3	26	....	70	....	....	....	
	4	9	....	90	....	....	....	
	5	9	....	88	....	....	....	
	6	....	....	....	20	21	39	Potato-starch and amonia alum.
	7	25	....	65	....	....	....	
	8	34	....	53	....	....	....	
	9	24	....	37	....	....	38	Corn-starch.
	10	65	5	17	....	....	....	
	11	83	13	....	....	....	....	Traces of sulphates and chlorides.
	12	90	7	....	....	....	....	
	13	83	11	....	....	....	....	
Y	1	73	....	20	....	....	....	
	2	84	11	....	....	....	....	
	3	75	....	24	....	....	....	
	4	10	....	90	....	....	....	

GROUND BLACK PEPPERS.

In the examination of the peppers the moisture was determined together with the ash and silicious residue. The average ash of the pure article is 4.17 per cent., of which about one-tenth or .42 per cent. of the pepper is insoluble in hydrochloric acid. Where foreign starches have been added the ash is diminished, unless, which is generally the case, there has been at the same time an admixture of mineral matter from the use of inferior and uncleaned pepper-corns. The extraneous mineral substances consist of sand and clay, and in a few cases such as W 2 and Z 7 the quantity is so large as to suggest their intentional addition for the gain in weight. The alcoholic extractive, consisting of piperine and resin, is not of much value in determining purity. It affords a means for estimating the relative value of pure samples; but in adulterated cases it is evident that mustard husks or linseed cake might give a large oily residue. The separation and estimation of the piperine would probably enable an approximative estimate of the percentage of adulteration to be made, but the object in view in these analyses did not require this. In fact the amount and character of the ash and the microscopic appearances are sufficient for the detection of adulteration.

All the samples consisted of loose pepper, except those B furnished by the Commissary-General, which were in quarter-pound cans, most of them having fancy labels bearing guarantees of purity. W 8 was put up in 1-ounce packages bearing the name of the mills where they were manufactured.

		Moisture.	Ash.	Sand, &c.	Alcoholic extract.	Remarks.
A	1	10.64	5.30	2.00	6.38	10 per cent. baked flour.
	2	11.10	4.44	.68	5.72	Pure, 40 cents per pound.
	3	11.28	3.38	.64	5.32	Large per cent. rice; 30 cents per pound.
	4	10.92	6.44	2.94	7.50	Baked flour and sand.
B	1	11.80	4.40	.40	7.26	Pure.
	2	11.44	6.40	1.88	7.42	Pure, but too much sand.
	3	10.70	4.00	.48	6.00	
	4	10.90	3.80	.80	5.70	
	5	12.70	4.10	.44	5.40	Pure.
	6	10.80	3.90	.12	7.00	
	7	11.90	3.76	.30	6.70	
	8	13.08	7.44	2.66	5.76	
	9	12.88	7.06	2.82	6.00	Pure, but for the sand.
	10	12.94	7.84	2.60	6.30	
	11	12.90	7.60	2.70	6.00	
	12	12.90	4.90	.68	7.80	Pure.
	13	11.78	4.10	.42	7.20	
	14	11.40	4.38	.48	6.90	Contains a few starch cells, apparently from ginger and probably accidental.
	15	12.64	5.26	1.58	6,00	Fresh wheat-flour 10 to 15 per cent.
	16	10.90	4.00	.62	5.20	Large percentage baked wheat-flour.
W	1	9.80	5.22	1.52	6.20	Large percentage rice, some wheat, and mustard husks. Extractive oily.
	2	9,28	9.34	4.26	6.14	Rice, mustard, and sand.
	3	10.12	4.00	.76	6.22	
	4	9.00	3.62	.70	5.64	Roasted wheat.
	5	7.76	4.00	1.16	4.90	
	6	7.62	7.68	3.00	6.88	Pure, but for the sand.
	7	8.18	5.82	.62	5.50	Roasted wheat.
	8	9.74	4.08	.92	3.80	Fresh and baked starches, wheat, corn, and beans.
	9	9.30	3.96	.90	5.50	Pure.
	10	8.08	3.44	.54	5.50	Rice, corn, and wheat.
	11	12.66	3.98	.84	6.36	Large percentage corn-flour.
	12	12.36	4.40	.60	6.24	Small percentage corn-flour.
	13	11.64	3.40	.42	3.80	Chiefly baked wheat.
	14	12,14	6.96	1.86	6.00	Pure, but for the sand.
Y	1	9.00	5.84	1.37	4.38	Rice and roasted wheat.
	2	8.50	3.94	.66	5.74	
	3	10.86	6.84	1.94	4.60	Rice.
	4	9.84	7.80	3.60	6.44	Sand and rice.
	5	9.66	4.20	.86	5.72	Rice, corn, cayenne, and turmeric.
	6	9.16	4.50	1.34	4.46	Roasted wheat and turmeric.
	7	10.74	6.48	1.92	6.60	Pure, but for sand.
	8	8.24	2.94	.40	2.90	Rice, roasted wheat, and turmeric.
	9	10.76	9.44	3.72	5.84	Roasted wheat.
	10	8.64	5.20	1.72	5.68	Rice and roasted wheat.
	11	8.44	6.12	.56	5.60	Roasted wheat.
Z	1	8.50	5.14	2.50	3.38	Roasted wheat and corn.
	2	9.60	6.72	1.74	6.78	Pure, but too much sand.
	3	12.14	5.94	2.00	6.38	Rice and sand.
	4	8.64	3.94	1.10	7.68	Rice and linseed husks.
	5	10.80	5.14	1.12	4.40	Corn-flour.
	6	8.92	5.24	1.12	4.20	Wheat, beans, and rice.
	7	9.30	8.34	5.24	7.34	Sand, small percentage wheat, and mustard.

Only one sample of white pepper was obtained. It was furnished by the dealer who sent in A 2 in the above list, and was marked 50 cents per pound. It was free from all extraneous matters and gave 11.08 percentage of moisture, 1.24 ash, .38 sand, and 7.28 extractive.

GROUND ALLSPICE.

In determining the purity of ground allspice reliance was placed on the microscope for the detection of foreign vegetable matters, and on the ash for the discovery of mineral adulterations. A sample of clean, whole allspice gave 3.92 per cent. of ash, with no sand or clay. The samples furnished by the Commissary-General were in ½ pound cans; the others were in bulk with the exception of W 1, which were put up in half-ounce packets.

	Ash.	Sand.	Microscopic characters, &c.
A 1	3.86	.16	Pure.
2	5.62	.46	
B 1	5.24	.12	
2	4.52	.18	Pure.
3	4.98	.18	

	Ash.	Sand.	Microscopic characters, &c.
W 1	3.86	.04	Large percentage of foreign starches.
2	6.90	2.26	Pure, but for the sand.
3	3.84	.12	Pure.
4	6.50	1.00	Large percentage corn-starch.
5	5.02	.01	Pure.
6	5.48	.04	
7	5.28	.12	
8	4.78	.20	
9	5.04	.04	
Y 1	4.20	.34	
2	3.60	.18	
3	5.64	.54	
4	4.90	.48	Bread crusts.
5	7.12	1.04	Roasted beans, wheat, and tumeric.
6	4.94	.44	Bread crusts.
7	5.96	1.66	Small percentage beans.
8	6.54	.64	Small percentage cloves and allspice, and much unknown woody tissues.
Z 1	3.94	.16	Pure.
2	5.80	.60	
3	4.36	.36	Large percentage corn-starch.
4	6.40	1.04	
5	4.90	.72	
6	4.40	.42	Bread crusts chiefly.

GROUND GINGER.

In the case of ginger also the ash and microscope were relied upon for the detection of impurities. The samples of the Subsistence Department were in cans obtained direct from the manufacturers; the others were in bulk.

	Ash.	Sand, &c.	Remarks.
A 1	5.34	1.48	Pure.
B 1	7.28	3.08	Pure, but No. 1 has by far too much sand.
2	5.16	1.38	
3	4.80	.84	
4	4.90	1.00	
5	4.68	.90	
W 1	3.14	.30	Bran of wheat, husks of black pepper, tumeric, and a little ginger.
2	2.48	.42	Mostly corn-starch.
3	6.46	2.43	Pure, but for the sand.
4	10.16	5.24	Ground rice and sand.
5	6.72	1.60	Wheat-flour.
6	3.30	.70	Corn-starch.
7	6.90	2.36	Sand and clay.
8	4.22	.74	Pure.
9	5.94	1.82	Pure, but sand too high.
10	4.48	.64	Pure.
Z 1	4.58	.76	Pure.

GROUND NUTMEGS.

Only one specimen of powdered nutmeg was sent for examination. It came from Nashville, Tenn., and was in a half-ounce packet with a fancy label. It gave 2.80 per cent. of ash and .04 of sand. Under the microscope it was found to be mixed with a considerable quantity of wheat starch.

GROUND MACE.

A few samples of ground mace were obtained. The letters indicate their origin. Very little mace was discoverable in the purchased specimens.

	Ash.	Sand.	Remarks.
A 1	2.72	.40	Turmeric and wheat-starch.
2	1.80	.06	Pure.
3	1.74	.06	Pure.
W 1	2.00	.08	Wheat-starch, rice, and turmeric.
Y 1	3.18	.48	Corn, wheat, and turmeric.
2	3.18	.76	Allspice and turmeric.
3	5.20	.22	Roasted beans, wheat, corn, and turmeric.
4	2.38	.36	Rice, allspice, wheat-bran, and turmeric.
5	2.24	.32	Corn-flour and turmeric.
6	2.44	.24	Corn and wheat flour and turmeric.
7	3.36	.56	Corn-flour and turmeric.

CLOVES.

Five samples of whole cloves, purchased in Washington, D. C., were found to be sound and good. Without being picked or cleaned they gave the following results:

	Ash.	Sand.
W 1	6.46	12
2	5.80	.20
3	6.20	.18
4	6.24	.12
5	6.04	.30
Average	6.15	.18

Manganese was very noticeable as a constituent of the ash of some of these specimens, as well as of those which follow.

GROUND CLOVES.

Most of these were examined for metallic impurities; but, as is evident from a superficial inspection of the two columns of figures below, the extraneous mineral matters in every case except W 7 consisted of the sand and clay adhering to the uncleaned buds and the vegetable products fraudulently mixed with them. Lime sulphate constituted the small excess in the exceptional case.

	Ash.	Sand, &c.	Remarks.
A 1	7.02	.58	Pure.
2	6.24	.38	
B 1	7.30	1.36	Pure.
2	5.40	.28	
W 1	6.48	.30	Pure.
2	7.56	1.04	
3	7.88	2.14	Allspice.
4	7.18	.88	Small per cent. allspice.
5	7.24	1.40	
6	5.76	.58	Large per cent. allspice.
7	8.74	.82	
Y 1	7.76	2.50	Roasted corn, wheat, beans, and sand.
2	7.50	1.62	Beans.
3	6.44	.80	Allspice and beans.
4	4.90	.86	Allspice and beans.
5	5.74	.90	Allspice.
6	4.60	.26	Beans and wheat.
7	6.74	.44	Allspice and beans.
Z 1	6.46	.94	Bread crusts.
2	6.10	.64	Allspice.
3	8.10	1.68	Small per cent. allspice.
4	8.00	1.44	Roasted corn and allspice.
5	7.72	1.28	Pure.
6	7.30	.94	Allspice and corn.

WHOLE CINNAMON.

One sample was obtained by purchase in Washington, D. C. It presented the general and microscopic characters of cassia, and gave 2.68 per cent. of ash and .06 of sand.

GROUND CASSIA.

Two samples in unbroken cans were furnished by the Commissary-General, United States Army. They gave the following results:

	Ash.	Sand.	Remarks.
B 1	4.77	.00	Pure.
2	5.44	.00	Contains wheat-starch.

It is worthy of remark that these specimens came from the same manufacturer, No. 1 being a sample can, and No. 2 one taken at random from the delivery on contract.

GROUND CINNAMON.

Cassia appeared to be the basis of all the adulterated specimens, except in W 6, where the imposture could only deceive those who were totally ignorant of the flavor of spices. The mineral matters consist, as usual, of sand and clay, accidentally present or intentionally added, as is probably the case in W 3 and 5, and in Z 5.

	Ash.	Sand, &c.	Remarks.
A 1	4.44	.44	Baked wheat-flour.
B 1	1.60	.06	Almond shells.
2	2.90	.32	Roasted beans and other articles.
3	4.26	.08	Pure.
W 1	3.44	.18	Corn-starch and turmeric.
2	3.60	.30	
3	7.38	3.50	Small percentage wheat; sand.
4	2.86	.20	Corn-starch.
5	6.84	4.62	Roasted wheat, turmeric, and red clay.
6	3.86	.38	Allspice chiefly, with wheat and other starches.
7	3.38	.20	Corn-starch, allspice, and turmeric.
8	3.88	.58	Bread-crusts and turmeric.
Y 1	3.92	.30	Bread-crusts.
2	4.12	.32	Bread-crusts and beans.
3	2.48	.04	Bread and almond shells.
4	4.00	.22	Cassia.
5	4.74	.96	Bread-crusts.
6	5.34	1.04	Almond shells.
7	4.68	.32	Small percentage beans.
8	2.62	.10	Cassia.
Z 1	3.30	.16	Corn-flour and almond shells.
2	2.94	.16	Corn-flour and turmeric.
3	2.46	.20	Cassia.
4	3.88	.10	Corn, almond shells, and turmeric.
5	8.90	4.14	Bread-crusts and corn-flour.
6	3.32	.24	Corn-flour, bread, and turmeric.

GROUND CAYENNE PEPPER.

None of the specimens contained any mineral adulterants other than the clay, which in some, as W 4 and Y 4, appears to have been an intentional admixture. The results are as follows:

	Ash.	Sand, &c.	Remarks.
A 1	4.68	.18	Pure.
B 1	6.30	.88	Corn-starch and turmeric, small percentage.
2	6.80	.48	Corn-starch and turmeric, large percentage.
3	6.80	.48	Corn-starch and turmeric, small percentage.
W 1	6.08	.44	Large percentage foreign starches.
2	6.30	1.30	Wheat and turmeric.
3	5.28	.40	Roasted wheat and turmeric.
4	7.00	3.38	Roasted wheat, turmeric, and red clay.
5	6.14	.84	Pure.
6	5.40	.44	Roasted wheat and turmeric.
7	5.30	.32	
Y 1	7.00	.20	Corn flour and turmeric.
2	10.14	2.46	
3	4.96	.30	
4	8.22	3.06	Ground rice and turmeric.
5	8.40	1.06	
6	6.24	1.10	Corn-flour, logwood, linseed, and deal sawdust.
7	5.36	.82	Corn-flour and turmeric.

MUSTARD.

In examining the mustards, the moisture, the ash and its insoluble residue, and the fixed oil as extracted by ether, were determined. In the first half dozen analyses the soluble salts of the ash were weighed, but as this experiment developed nothing which could not be inferred from the weight of the ash and its silicious residue, it was omitted in subsequent examinations. Sulphate of lime appeared in the ash in a few instances. The estimation of the oil shows that this constituent of the seed is usually expressed before the mustard is ground. Hassall states the normal quantity of fixed

oil to be 35.7 per cent. The sample W 1 in the following list gives 28 per cent. and Z 7 23.4 per cent., but the others are notably deficient, even those which are unmixed with debasing substances.

The pure mustards, W 5 and 11, were faded in color, and would no doubt have been viewed with suspicion by the public who are accustomed to the bright color given by the turmeric admixture. W 1 and 2, Z 3 and 4, and D 3 were put up in small cans; the others were in bulk:

		Moisture.	Ash.	Sand, &c.	Oil.	Remarks.
A	1	7.80	2.88	.10	18.32	Wheat-flour and turmeric.
	2	8.24	4.90	.28	14.30	
W	1	6.02	4.16	.10	28.04	10 per cent. wheat-starch.
	2	6.20	5.40	.28	13.80	Wheat-flour.
	3	5.60	11.20	.70	15.57	Corn-starch and lime sulphate.
	4	8.94	5.76	.50	6.08	Chiefly rice and turmeric, with a little mustard and cayenne.
	5	5.84	5.82	.74	15.22	Pure.
	6	7.84	4.40	.08	8.00	Large percentages of wheat-starch and turmeric.
	7	6.72	4.50	.08	8.44	
	8	7.54	3.96	.22	7.14	
	9	6.58	3.50	.44	13.44	
	10	7.26	3.70	.48	12.94	
	11	5.92	6.44	.64	15.64	Pure.
	12	5.74	10.10	.90	9.54	Large percentage wheat and 7.96 per cent. lime sulphate.
	13	7.86	2.90	.40	6.04	Chiefly rice.
	1	9.66	5.48	.32	5.50	Rice and turmeric.
	2	9.60	5.96	.38	6.10	
	3	8.74	6.56	.32	6.60	Wheat and turmeric.
	4	10.96	3,70	.38	6.60	Rice, and a little wheat and turmeric.
	5	5.85	12.94	.24	13.90	Wheat, turmeric, cayenne, and lime sulphate.
	6	9.26	3.94	.44	13.60	Wheat and turmeric.
	7	4.90	5.14	.84	23.40	A small percentage wheat.
	8	7.06	10.74	1.08	8.10	Wheat and turmeric and lime sulphate.
	1	5.75	7.05	1.55	15.20	Pure.
	2	5.65	4.80	.35	15.83	
	3	5.60	4.50	.35	20.70	
	4	5.30	6.75	.95	17 50	

VINEGARS.

The ash in each of the samples was examined for metallic impurities. The presence f carbonates in the ash showed the absence of mineral acids. A 3 and W 1 were alive ith anguillula.

	Specific gravity.	Strength in percentage of monohydrated acid.	Strength in grains of bicarb. soda, neutralized by 1 oz. of 480 grs.
1	1013.9	3.66	24.6
2	1022.1	7.12	47.8
3	1010.7	3.62	24.3
4	1008.0	2.57	17.2
1	1015.9	2.56	17.2
1	1008.4	5.22	35.1
1	1013.4	4.09	27.5
2	1004.4	2.92	19.6
3	1020.0	3.04	20.4
4	1013.4	4.07	27.3
5	1007.7	3.30	22.2
6	1007.7	3.24	21.8
7	1014.4	3.36	22.6
8	1009.8	3.00	20.2
9	1010.2	3.36	22 6

PICKLES.

One sample of pickles was sent in for examination by the Paymaster-General of the avy. It was free from copper and mineral acids, and the liquor contained 3.06 per nt. of monohydrated acetic acid.

APPENDIX F.

GAUGING OF PUBLIC SEWERS.

BY GEORGE E. WARING, JR.

NEWPORT, R. I., *July* 19, 1880.

SIR: Appended hereto please find my report on the gaugings of sewers in different parts of the country, which have been carried on during the past year under my direction by the order of the National Board of Health.

Respectfully, yours,

GEO. E. WARING, JR.

DR. T. J. TURNER,
Secretary National Board of Health.

The purpose of these gaugings was to determine the size of conduit needed for the removal of the greatest amount of sewage matter produced by given populations; in other words, to determine the degree to which it would be safe to reduce the sizes of public sewers in cases where the object is only to remove the foul sewage matters of households, manufacturing establishments, public institutions, &c. No attempt was made at an elaborate scientific examination of the flow, beyond what was necessary for this one purpose.

It has been almost the universal custom up to this time, in planning a system of sewers for a town, large or small, to regulate the sizes of the sewers with a view to the removal not only of domestic and manufacturing wastes, but also of a considerable amount of rainfall. This custom is open to several objections:

(1.) Sewers large enough for the removal of storm-water are so much too large for domestic sewage that they must inevitably be foul and in a bad sanitary condition, except when flushed by storm-water. As storm-water is often withheld for many weeks together, and often at a season when the decomposition of deposits in the sewer is most active and injurious, this condition constitutes a very grave sanitary defect.

(2.) While the cost of storm-water sewers may be born with tolerable ease in a city where the whole abutting property is built up, the distribution of such a charge among the scattered inhabitants of a more village-like town, where lot fronts are often very much larger than in the city, constitutes a serious burden—so serious, indeed, as to be in many instances prohibitory.

(3.) Aside from the foul air produced in the sewers themselves, the decomposition of the filth which accumulates in the catch-basins, by which street-water is admitted to the sewers, is often a source of most serious offense, if not danger.

(4.) By extending the underground removal of storm-water to the very crests of the elevations of a town, the gutter flow, even at points where it could cause no inconvenience, is so much reduced as to prevent the cleansing of the gutters, which would otherwise be effected with each storm.

So serious are the objections above cited, that I have found in more than one case serious opposition to the construction of sewers on the part of local sanitary authorities. In Baltimore for example, where the removal not only of surface water, but of the liquid wastes of households, is effected by surface drainage only, a very influential portion of the community strenuously resists all projects for sewerage, because of the advantage that they believe now to be derived from the cleansing effect of storm-water flowing through the streets.

It seems to me more than questionable whether it would not be better to preserve the surface removal of rain-water in all parts of the town where its accumulation would rarely amount to a serious interference with the use of the streets, and where injury to private property is not to be apprehended. This would enormously reduce the length and consequently the cost of the storm-water system, and would at least confine to certain limited localities the objectionable features which are now so prominent.

There seems to be good ground for the belief that if the sizes of sewers can be adjusted to the removal of foul wastes only, not only will their condition be very

mproved, but their cost will be so vastly reduced as to bring their advantages the reach of the smallest communities.

ıe most important step in determining the practicability of the changes above ed, the National Board of Health commissioned me to institute such a series gings as would determine the actual pipe capacity required. Formulæ in use engineers would lead to substantially the same result with actual gaugings; eir educational effect would be less marked, because calculations based upon fic formulæ are less readily comprehended by the average municipal ruler.

ırsuance of the instructions of the board, I have instituted the following gaug-

sewer in Madison avenue, in New York, having, with its branches, a total length ut 7,000 feet, and occupying a district about half built up with houses of good

sewer in a single street in Providence, R. I.

sewer with a single short branch in Burlington, Vt.

x sewers in a closely-built part of the city of Milwaukee, Wis.

ıe sewers draining the New York State Lunatic Asylum, at Poughkeepsie.

characteristic sewer in the city of Poughkeepsie, N. Y.

he sewers draining the Massachusetts Hospital for the Insane, at Taunton, Mass.

large sewer in Saint Louis, Mo.

total result of these gaugings affords a very fair average result, covering a suffi- ariety of conditions, upon which I submit the following summary of the facts ped:

MADISON AVENUE SEWER, NEW YORK.

gauging was intrusted to Stevenson Towle, esq., civil engineer, the engineer ge of the sewer department of New York, who kindly consented to make the gations. Unfortunately his other occupations did not enable him to complete ork, and I am only able to say that the greatest flow of the Madison avenue was discharged through a notch (in a weir) 4 inches wide, which it filled to a of 3½ inches.

PROVIDENCE, R. I.—PINE STREET SEWER.

investigation was made by J. A. Judson, esq., civil engineer, whose report may ımarized as follows: The total length of this sewer is 1,391 feet. Its grade from 0.86 per 100 to 4.18 per 100. The district which it drains contains 60 , all of which are residences, and 41 of which are connected with the sewer. ıuging in this, as in all other cases, was taken at the time of the greatest use of of the week, in this case on Monday morning, between the hours of 8 and 11. pth of flow was measured at intervals of fifteen minutes. The population trib- to the sewer numbers 267. The result showed that the greatest flow of sewage d a depth of 0.4375 inch in the 12-inch sewer. In the reducer, which brought rrent into a channel having a radius of 3 inches, the greatest depth of flow was A pipe 1.84 inches in diameter, running full at the same velocity, would carry eatest flow of sewage from this population of 267.

BURLINGTON, VT.—COLLEGE STREET SEWER.

ganging was made by A. R. Dow, esq., city engineer. The total length of this and its branch is 2,790 feet. Its grade varies from 0.435 per 100 to 3.39 per 100. strict which it drains contains 85 houses, of which 54 are connected with the Forty-nine of these are dwelling-houses, and 5 are stores and shops. The ıtion tributary to the sewer embraces 325. The ganging was taken at intervals ainutes from 7.30 a. m. to 10.30 a. m. The result showed that the greatest flow age reached a depth of 1.2 inches in a pipe of 3-inch radius. A pipe 2.25 inches neter, running full at the same velocity, would carry the greatest flow of sewage his population of 325 persons.

MILWAUKEE, WIS.

se gauges were made by A. H. Scott, esq., civil engineer, of the city engineer's in the sewers of Detroit, Martin, Chestnut, Biddle, Wisconsin, and Huron t.

gaugings of the Huron street sewer are of especial significance. This sewer is hes in diameter. The grade of the sewer at the point where the gaugings were was about 1 in 400. The area tributary to the sewer is about 70 acres, all nearly closely built, containing 500 houses, mostly dwellings, and a total population of One hundred and thirty-two of the buildings are not connected with the sewer;

the remaining 368 buildings contain a total population of 3,177, all of whom are tributary to the sewer. There are several hotels, saloons, small factories, and livery stables; so that the district is fairly representative of an average city area.

The greatest flow in the main sewer on "washing day"—the greatest flow of the week—attained a depth of 6 inches, the diameter of the sewer being 42 inches.

The channel being reduced to a diameter of 10 inches, the greatest depth of the flow was 4.5 inches. Reduced to a diameter of 8 inches the depth remained the same—4.5 inches. Reduced to a diameter of 6 inches, it reached a depth of 5.5 inches.

The influence on the velocity of the stream by increasing its hydraulic mean depth is illustrated by the following figures:

"Forty-two inch sewer, 6 inches deep; cross-section of stream, 121.3 square inches.
"Ten-inch sewer, 4.5 inches deep; cross-section of stream, 33.1 square inches.
"Eight-inch sewer 4.5 inches deep; cross-section of stream, 27.7 square inches.
"Six-inch sewer, 5.5 inches deep; cross-section of stream, 27.14 square inches."

POUGHKEEPSIE, N. Y.—HUDSON RIVER STATE HOSPITAL.

This gauging was made by J. A. Judson, esq., civil engineer. This institution uses a daily average of about 80,000 gallons of water. The entire waste, including boiler-house, laundry, and kitchens, is discharged through a main sewer 12 inches in diameter. Its least fall is 1 foot in 100 feet, and its *average* fall is about 5 feet in 100 feet, so that its contents flow at high velocity. On the day of examination, January 17, 1880, the hospital had 301 inmates—241 patients and 60 employés. The flow was measured between 9 a. m. and 12 m., at intervals of ten minutes. The maximum discharge took place at 9.30. The channel was reduced to a diameter of 6 inches, and the measurements were made with a thin strip of wood set edgewise to the current. The maximum flow attained a depth of 3.25 inches. At 9.20 it had attained 2.50 inches, and at 9.40 it reached only 2.75 inches. At 11.20 it again touched 3 inches.

A concise statement of the case would be this: 301 persons consuming 80,000 gallons of water per day, being 265 gallons per head, produced an amount of sewage sufficient at its maximum to create a stream in a 6-inch pipe 3¼ inches deep.

The greatest flow (3.25 inches) would have been carried by a pipe 4.25 inches in diameter, running full at the same velocity.

POUGHKEEPSIE, N. Y.—MARKET STREET SUBDISTRICT SEWER.

This gauging was conducted by J. A. Judson, esq., civil engineer. This is a 15-inch vitrified pipe sewer, draining Church street, Noxon street, and a part of Market street. The total length of the sewer delivering at the point of gauging is 2,766 feet. The number of houses tributary to the sewer was 39, and the population 426. The greatest flow of their sewage, measured in a pipe 6 inches in diameter, was 2.25 inches. It might all have been carried in a pipe a trifle more than 3 inches in diameter.

TAUNTON, MASS.—STATE LUNATIC ASYLUM.

The gaugings at this hospital were conducted by J. A. Judson, esq., civil engineer. This hospital is situated about one mile south of the city, on elevated ground, near Mill River. The building is large and is abundantly supplied with water from its own steam-pumping works, about 40,000 gallons per day being used for all purposes, including the laundry. The main sewer is a 10-inch iron pipe. This sewer carries away, in addition to roof-water, the entire waste of the establishment with the exception of the laundry, which delivers through an independent sewer to be referred to hereafter.

The flow of the 10-inch sewer was reduced to a diameter of 6 inches, and gaugings were taken at the usual intervals of ten minutes during the time of the greatest use of water in the establishment. The summary of the report shows that the population occupying this hospital, 659 in number, produced sewage matter from all sources, except the laundry, sufficient to cause a depth of flow in the 6-inch pipe of only 1¾ inches at the greatest. A sewer 3 inches in diameter (2.96) would, with a flow of the same velocity, discharge the greatest amount yielded by this population.

A separate investigation of the flow of the laundry sewer showed very great variations, due to the fact that sometimes one and sometimes all of the large washing machines, five in number, were emptied suddenly, producing a great momentary increase. The minimum flow between 9.30 and 11.30 a. m. was less than 1 inch in depth (.875). At 10.40 a. m. the maximum flow was produced by the simultaneous emptying of all the machines. This raised the depth of water in the 6-inch pipe to 2¼ inches. In ten minutes it had fallen to 1¼ inches. The maximum flow would have been carried at the same velocity through a pipe 3.50 inches in diameter.

The entire maximum flow of the two sewers would have been carried, supposing the velocity to be the same, in a pipe 4.58 inches in diameter. (It is worthy of notice that

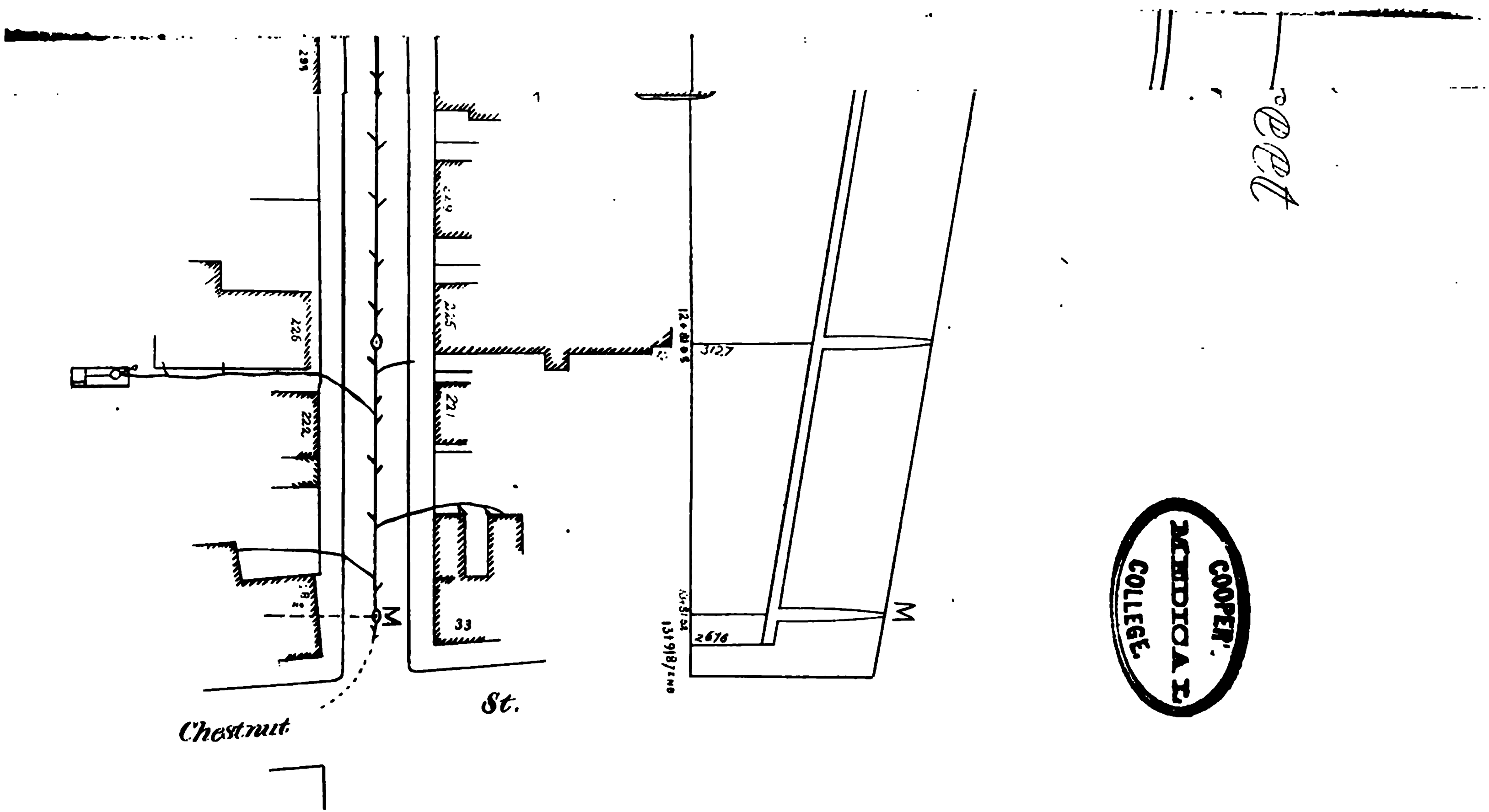
12+81.05
3127
M
2676
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Table accompanying report of A. H. Scott, C. E., on Huron street sewer, Milwaukee, Wis.

Number of block.	Name of street.	Street number.	Purpose of building.	Number of inhabitants.	Not connected.		Connected.		Remarks.
					Inhabitants.	Total inhabitants.	Inhabitants.	Total inhabitants.	
5	Huron	63	Lithography	40	40				Transitory population.
5	East Water	327	Cigar factory	30	30				Do.
5	do	323	Clothing house	100	100				Do.
5	do	319	Store	6	6				Do.
5	do	317	do	2	2				Do.
5	do	315	do	4	4				Do.
5	do	311	do	12			12		Do.
5	do	809	do			182		12	Vacant.
6	do	328	Banks and offices	30			30		Transitory population.
6	do	326	Store	27			27		Do.
6	do	320	do	14			14		Do.
6	do	316	do						Vacant, connected.
6	do	312	do	4			4		
6	do	310	Saloon and dwelling	3			3		
6	Huron	89	Shoe factory	35			35		Transitory population.
6	do	91	Store	6			6		
6	do	93	do	Vacant.					Connected.
6	do	95	do	do					Do.
6	Broadway	309	Saloon and dwelling	4			4		
6	do	311-3	Lithography	40			40	163	Transitory population.
15	do	310	Boarding house	36			36		
15	do	312	Livery stable	2			2		Eight horses.
15	do	316	Saloon and dwelling	4			4		
15	do	322	Horseshoeing establishment	8			8		
15	do	324	Store	Vacant.					Connected.
15	do	236-8	do	18			18		
15	Huron	113-121	Cigar factory	350			350		Transitory population.
15	do	123	Boarding house	7			7		
15	Milwaukee	309-11	Barn	8			8		Sixteen horses.
15	do	313	Dwelling	2			2		
15	do	315	do	8			8	443	
16	Huron	142-7	American express stables	13			13		Nineteen horses.
16	do	139	Saloon and dwelling	6			6		
16	do	137	do	9	9				
16	do	135	Shop and dwelling	5			5		
16	do	133	do	18			18		
16	do	131	Saloon and dwelling	4			4		
16	do	129	Bakery and dwelling	4			4		
16	do	125-7	Store and dwelling	12			12		

16	Milwaukee	318–320	Cabinet shop	11			11		Transitory population.
16	do	316	Dwelling	3			3		
16	do	314	do	8		9	8	84	
16	do	312	do	5			8		
16	do	310	Saloon and dwelling	4			4	12	
25	Jefferson	318	do	8			8		
25	do	316	do	8			8		
25	Huron	145–7	Store and dwelling	12			12		
25	do	151	do	12			12		
25	do	153	do	14			14		
25	do	155	do	10	10				
25	do	157	do	16	16				
25	do	159	do	10	10				
25	do	161–3	Shop and dwelling	9			9		
25	do	165	do	6			6		
25	do	167	do	5	5				
25	do	169	do	5	5				
25	do	171	do	6	6				
25	Jackson	323	do	5	5	57		69	
26	do	320	do	12			12		
26	do	318	do	7			7		
26	do	316	do	8			8		
26	do	314	do	8			8		
26	do	310	do	6			6		
26	Huron	181	do	6	6				
26	do	185	do	6	6				
26	do	187	do	8			8		
26	do	189	do	6			6		
26	do	191	do	3	3				
26	do	193–5	do	8			8		
26	Van Buren	321	do	6	6				
26	do	319	do	1	1				
26	do	317	do	3	3				
26	do	315	do	9			9		
26	do	311–13	do	20			20		
26	do	309	do	11			11		
26	do	307	do	2	2				
26	do	305	do	4			4		
26	do	303	do	3			3		
26	do	301	do	7			7		
26	do	299	do	3			3		
26	Detroit	188	do	4	4				
26	do	186	Store and dwelling	2	2				
26	do	190	do	8	8	41		120	
26	Detroit	194	Dwelling	1	1				
26	do	196	do	5		1	5	5	
35	Van Buren	202	Dwelling and store	5			5		
35	do	204	do	2			2		
35	do	206	do	2	2				
35	do	208	do	Vacant.					Not connected.
35	do	210	do	8	8				
35	do	212	do	6			6		

Table accompanying report of A. H. Scott, C. E., on Huron street sewer, Milwaukee, Wis.

Number of block.	Name of street.	Street number.	Purpose of building.	Number of inhabitants.	Not connected. Inhabitants.	Not connected. Total inhabitants.	Connected. Inhabitants.	Connected. Total inhabitants.	Remarks.
5	Huron	63	Lithography	40	40				Transitory population.
5	East Water	327	Cigar factory	30	30				Do.
5	do	323	Clothing house	100	100				Do.
5	do	319	Store	6	6				Do.
5	do	317	do	2	2				Do.
5	do	315	do	4	4				Do.
5	do	311	do	12			12		Do.
5	do	809	do			182		12	Vacant.
6	do	828	Banks and offices	30			30		Transitory population.
6	do	826	Store	27			27		Do.
6	do	820	do	14			14		Do.
6	do	816	do						Vacant, connected.
6	do	812	do	4			4		
6	do	310	Saloon and dwelling	3			3		
6	Huron	89	Shoe factory	35			35		Transitory population.
6	do	91	Store	6			6		
6	do	93	do	Vacant.					Connected.
6	do	95	do	do					Do.
6	Broadway	309	Saloon and dwelling	4			4		
6	do	311-3	Lithography	40			40	163	Transitory population.
15	do	310	Boarding house	36			36		
15	do	312	Livery stable	2			2		Eight horses.
15	do	316	Saloon and dwelling	4			4		
15	do	322	Horseshoeing establishment	8			8		
15	do	324	Store	Vacant.					Connected.
15	do	236-8	do	18			18		
15	Huron	113-121	Cigar factory	350			350		Transitory population.
15	do	123	Boarding house	7			7		
15	Milwaukee	309-11	Barn	8			8		Sixteen horses.
15	do	313	Dwelling	2			2		
15	do	315	do	8			8	443	
16	Huron	143-7	American express stables	13			13		Nineteen horses.
16	do	139	Saloon and dwelling	6			6		
16	do	137	do	9	9				
16	do	135	Shop and dwelling	5			5		
16	do	133	do	18			18		
16	do	131	Saloon and dwelling	4			4		
16	do	129	Bakery and dwelling	4			4		
16	do	125-7	Store and dwelling	12			12		

16	Milwaukee	318–320	Cabinet shop	11			11		Transitory population.
16	do	316	Dwelling	3			3		
16	do	314	do	8		9	8	84	
16	do	312	do	6			8		
16	do	310	Saloon and dwelling	4			4	12	
25	Jefferson	318	do	8			8		
25	do	316	do	8			8		
25	Huron	145–7	Store and dwelling	12			12		
25	do	151	do	12			12		
25	do	153	do	14			14		
25	do	155	do	10	10				
25	do	157	do	16	16				
25	do	159	do	10	10				
25	do	161–3	Shop and dwelling	9			9		
25	do	165	do	6			6		
25	do	167	do	5	5				
25	do	169	do	5	5				
25	do	171	do	6	6				
25	Jackson	323	do	5	5	57		60	
26	do	320	do	12			12		
26	do	318	do	7			7		
26	do	316	do	8			8		
26	do	314	do	8			8		
26	do	310	do	6			6		
26	Huron	181	do	6	6				
26	do	185	do	6	6				
26	do	187	do	8			8		
26	do	189	do	6			6		
26	do	191	do	3	3				
26	do	193–5	do	8			8		
26	Van Buren	321	do	6	6				
26	do	319	do	1	1				
26	do	317	do	3	3				
26	do	315	do	9			9		
26	do	311–13	do	20			20		
26	do	309	do	11			11		
26	do	307	do	2	2				
26	do	305	do	4			4		
26	do	303	do	3			3		
26	do	301	do	7			7		
26	do	299	do	3			3		
26	Detroit	188	do	4	4				
26	do	186	Store and dwelling	2	2				
26	do	190	do	8	8	41		120	
26	Detroit	194	Dwelling	1	1				
26	do	196	do	5		1	5	5	
85	Van Buren	202	Dwelling and store	5			5		
85	do	204	do	2			2		
85	do	206	do	2	2				
85	do	208	do	Vacant.					Not connected.
85	do	210	do	8	8				
85	do	212	do	6			6		

Table accompanying report of A. H. Scott, C. E., on Huron street sewer, Milwaukee, Wis.—Continued.

Number of block.	Name of street.	Street number.	Purpose of building.	Number of inhabitants.	Not connected. Inhabitants.	Not connected. Total inhabitants.	Connected. Inhabitants.	Connected. Total inhabitants.	Remarks.
85	Van Buren	216	Store and dwelling	9	9				
85	do	218	do	6			6		
85	do	220	do	10			10		
85	do	222	do	8			8		
85	do	224	do	8	8				
85	Huron	199	do	5	5				
85	do	201	do	4	4				
85	do	203	do	5	5				
85	do	205	do	4			4		
85	do	207	do	5			5		
85	do	211	do	5	5				
85	do	213	Store	8			8		
85	do	215	Dwelling	11	11				
85	do	217	do	5	5				
85	do	221	do	4			4		
85	do	223	do	3			3		
85	do	225	do	5			5		
85	do	227	do	3			3		
85	do	231	do	3	3				
85	do	237	do	5	5	70		69	
4	East Water	329–331	Store and saloon	17	17				
4	do	333–5	do	12	12				
4	do	337	do	Vacant.					Not connected.
4	do	339	do	15			15		Transitory population.
4	do	341–3	do	7	7				
4	do	345	do	Vacant.					Not connected.
4	do	347	do	19	19				
4	do	351–3	Store and candy factory	60	60				
4	do	355–7	do	17			17		
4	do	359	do	12	12				
4	do	361–3	Store and bookbindery	37	37	164			
7	do	330–2	Store	15			15		
7	do	334–6	do	Vacant.				47	Connected.
7	do	338	do	6			6		Transitory population.
7	do	340	do	8			8		Do.
7	do	342	do	11			11		Do.
7	do	344	do	7			7		Do.
7	do	346	do	6			6		Do.
7	do	348–50	do	15			15		Do.

7	East Water	352	Store	15			15		Do.
7	do	354-6	do	20			20	88	Do.
7	Broadway	329-33	do	30			30		Do.
7	do	335-7	do	8			8		Do.
7	do	339	do	8			8		Do.
7	do	341	do	7			7		Do.
7	do	343-5	do	20			20		Do.
7	do	347-9	do	7			7		Do.
7	do	351-363	New chamber commerce					80	Connected, not yet occupied.
14	do	330	Saloon and dwelling	8			8		
14	do	332	Laundry and dwelling	17			17		
14	do	338	Store	18			18		
14	do	340	do	15			15		
14	do	344	Livery stable	6			6		Twenty-four horses.
14	do	348	Store	Vacant.					Connected.
14	do	352	do	20			20		
14	do	356	do	5			5		
14	do	360	do	35			35		
14	do	364	do	15			15		
14	do	110	do	3			3		
14	do	112	do	2			2		
14	do	116	do	7			7		
14	do	118	Saloon and dwelling	11			11		
14	do	120	do	5			5		
14	do	124	Dwelling	5			5		
14	Milwaukee	335	do	7			7		
14	do	337	do	4	4				
14	do	341	do	6			6		
14	do	345	do	8			8		
14	do	351	do	4	4				
14	do	357	do	8	8				
14	do	363	do	10	10	26		103	
17	do	358	do	4			4		
17	do	356	do	2			2		
17	do	354	do	6			6	12	
17	do	352	Shop and dwelling	9			9		
17	do	350	do	8			8		
17	do	348	do	9			9		
17	do	346	do	6			6		
17	do	344	Dwelling	Vacant.					Connected.
17	do	342	Shop and dwelling	9			9		
17	do	340	do	6			6		
17	do	338	Dwelling	3			3		
17	do	336	do	8			8		
17	Huron	126	Saloon and dwelling	39			39		
17	do	128	Store and dwelling	3			3		
17	do	130	do	2			2		
17	do	132	do	7			7		
17	do	132½	do	7			7		
17	do	136	do	15			15		
17	do	140	do	7			7		
17	do	144	Dwelling	5			5		

Table accompanying report of A. H. Scott, C. E., on Huron street sewer, Milwaukee, Wis.—Continued.

Number of block.	Name of street.	Street number.	Purpose of building.	Number of inhabitants.	Not connected. Inhabitants.	Not connected. Total inhabitants.	Connected. Inhabitants.	Connected. Total inhabitants.	Remarks.
17	Huron	146–148	Bakery and dwelling	12			12		
17	Jefferson	355	Saloon and dwelling	2			2		
17	do	353	Dwelling	4			4		
17	do	351	do	4			4		
17	do	349	do	4			4		
17	do	347½	do	5			5		
17	do	347	do	4			4		
17	do	345	do	9			9		
17	do	343	do	7			7		
17	do	341	do	3			3		
17	do	339	do	5			5		
17	do	337	do	8			8	210	
24	do	360	do	10			10		
24	do	358	do	8			8		
24	do	356	do	12			12		
24	do	354	Church						
24	do	350	Dwelling	7			7		
24	do	346	do	9			9		
24	do	344	do	14			14		
24	do	342	do	7			7		
24	do	340	do	4			4		
24	do	338	do	7			7		
24	do	336	do	10			10		
24	Huron	150	Store	2			2	90	
24	do	152	Dwelling	8			8		
24	do	154	do	5			5		
24	do	156–158	do	13			13		
24	do	160	Saloon	3			3		
24	do	162	Dwelling	9			9		
24	do	172	Hotel	60			60		
24	Jackson	335½	Dwelling	7			7		
24	do	337	do	4			4		
24	do	339	do	3			3		
24	do	343	do	3			3		
24	do	347	do	10			10		
24	do	351	do	11			11		
24	do	353	do	8			8		
24	Michigan	149	do	30			30		
24	do	155	do	9			9		

24	......do	159	......do	10		10	
24	......do	161	......do	9		9	
24	......do	163	......do	9		9	
24	......do	165	......do	5		5	
24	......do	167	......do	4		4	
24	......do	169	......do	5		5	225
27	Huron	174	Dwelling and store	5		5	
27	......do	180	Dwelling	13		13	
27	......do	182	......do	10		10	
27	......do	184	......do	6		6	
27	......do	186	Dwelling and shop	9		9	
27	......do	190	Dwelling	4		4	
27	......do	196	Dwelling and store	25		25	
27	Jackson	336	Dwelling	5		5	
27	......do	338	......do	2		2	
27	......do	340	......do	2		2	
27	......do	342	......do	11		11	
27	......do	344	......do	2		2	
27	......do	346	......do	1		1	
27	......do	348	......do	11		11	
27	......do	350	......do	3		3	
27	......do	352	......do	6		6	
27	......do	354	......do	2		2	
27	Michigan	173	......do	6		6	
27	......do	177	......do	7		7	
27	......do	181	......do	7		7	187
27	......do	183	Dwelling	5		5	
27	......do	185	......do	6		6	
27	......do	187	......do	5		5	
27	......do	189	......do	4		4	
27	......do	191	......do	3		3	
27	......do	193-195	Store and dwelling	5		5	
27	Van Buren	337	Dwelling	3		3	
27	......do	339	......do	5		5	
27	......do	341	......do	8		8	
27	......do	343	......do	8		8	
27	......do	345	......do	3		3	
27	......do	347	......do	5		5	
27	......do	351-153	......do	10		10	
27	......do	355	......do	5		5	
27	......do	657	......do	6		6	81
86	Huron	198	Store and dwelling	8	8		
86	......do	202	Dwelling	8	8		
86	......do	204	......do	2	2		
86	......do	206	......do	9	9		
86	......do	208	......do	2		2	
86	......do	210	......do	5	5		
86	......do	212	Store and dwelling	6		6	
86	......do	214	Dwelling	5		5	
86	......do	216	......do	9		9	
86	Cass	329	......do	4		4	
86	......do	335	......do	2		2	

Table accompanying report of A. H. Scott, C. E., on Huron street sewer, Milwaukee, Wis.—Continued.

Number of block.	Name of street.	Street number.	Purpose of building.	Number of inhabitants.	Not connected.		Connected.		Remarks.
					Inhabitants.	Total inhabitants.	Inhabitants.	Total inhabitants.	
86	Cass	337	Dwelling	5			5		
86	......do	339	......do	3			3		
86	......do	345	......do	7	7				
86	......do	351	......do	5	5				
86	......do	353	......do	3			3		
86	......do	357	......do	2			2		
86	......do	361	......do	7			7		
86	Van Buren	336	......do	7	7				
86	......do	338	......do	2	2				
86	......do	340	......do	5	6				
86	......do	342	Two dwellings	Vacant.					Not connected.
86	......do	344	Dwelling	6	6				
86	......do	346	......do	6	6				
86	......do	348	......do	4	4				
86	......do	352	......do	9	9	73		48	
86	......do	354	......do	Vacant.					Connected.
86	......do	356	......do	7			7		
86	......do	358	......do	4			4		
86	Michigan	197	Store and dwelling	11			11		
86	......do	199	Dwelling	4			4		
86	......do	201	......do	5			5		
86	......do	203	......do	5			5		
86	......do	209	Soap factory and dwelling	6			6		
86	......do	211	Dwelling	6			6		
86	......do	213	......do	4			4	52	
99	Huron	228–234	Brewery	2	2				Not operated.
99	Cass	356	Dwelling	3			3		
99	......do	354	Tailor-shop	65			65		
99	......do	352	Dwelling	6	6				
99	......do	350	......do	5	5				
99	......do	348½	......do	3	3				
99	......do	348	......do	7	7				
99	......do	346	......do	13			13		
99	......do	342	......do	5			5		
99	Michigan	223	......do	4			4		
99	......do	225	......do	4			4		
99	......do	227	......do	8			8		
99	......do	229	......do	4			4		
99	......do	237	......do	5			5		

28	do	239	do	16		23	16	127	
28	Van Buren	373	do	4			4		
28	do	375	do	6			6		
28	do	377	do	7			7		
28	do	379	do	7			7		
28	do	383	do	5			5		
28	do	385	do	4			4		
28	do	387	do	5			5		
28	Wisconsin	173	do	5			5		
28	do	181	do	12			12		
28	do	185	do	1			1		
28	do	187	do	6	6	6			
28	do	189	do	8			8		
28	do	193	Store and dwelling	5			5		
28	Michigan	196	Dwelling	8			8		
28	do	194	do	4			4		
28	do	192	do	4			4	85	
28	do	190	Dwelling	4			4		
28	do	188	do	7			7		
28	do	186	do	1			1		
28	do	184	do	11			11		
28	do	182	do	6			6	29	
87	Van Buren	368	do	10			10		
87	do	372	do	4			4		
87	do	374	do	5			5		
87	do	376	do	7			7		
87	do	382	do	Vacant.					Connected.
87	do	384	do	do					Do.
87	do	386	do	4			4		
87	do	388	do	6			6		
87	do	392	do	7	7	7			
87	Cass	385	do	10			10		
87	do	383	do	6			6		
87	do	381	do	5			5		
87	do	379	do	5			5		
87	do	377	do	4			4		
87	do	371	do	2			2		
87	Michigan	212	do	8			8		
87	do	210	Saloon	3			3		
87	do	206	Dwelling	7			7		
87	Wisconsin	197	do	2			2		
87	do	199	do	4			4		
87	do	201	do	4			4		
87	do	205	do	4	4				
87	do	207	do	7	7	11			
87	do	211	do	4			4		
87	do	213	do	4			4		
87	do	215	do	7			7	111	
98	Beach	375	do	10			10		
98	do	373	do	5			5		
98	do	371	do	3			3		
98	do	387	do	8			8		

Table accompanying report of A. H. Scott, C. E., on Huron street sewer, Milwaukee, Wis.—Continued.

Number of block.	Name of street.	Street number.	Purpose of building.	Number of inhabitants.	Not connected.		Connected.		Remarks.
					Inhabitants.	Total inhabitants.	Inhabitants.	Total inhabitants.	
98	Beach	385	Dwelling	6			6		
98	do	381	do	2	2				
98	do	379	do	10	10	12			
98	do	377	do	7			7		
98	Cass	374	do	10			10		
98	do	376	do	5			5	54	
98	do	378	do	5			5		
98	do	380	do	4	4				
98	do	382	do	2	2				
98	do	384	do	12			12		
98	do	388	do	5	5				
98	do	390	do	5			5		
98	Michigan	242	do	6			6		
98	do	240	do	2			2		
98	do	236	do	8			8		
98	Wisconsin	253	do	10			10		
98	do	251	do	2			2		
98	do	247	do	8			8		
98	do	243	do	3			3		
98	do	241	do	2			2		
98	do	239	do	2			2		
98	do	237	do	5			5		
98	do	235	do	2			2		
98	do	233	do	3			3		
98	do	231	do	5			5		
98	do	223	do	3		11	3	83	
29	Mason	187	Livery stable	2	2				
29	do	191	Dwelling	3	3				
29	do	193	do	4	4				
29	Van Buren	429	do	5	5				
29	do	423	do	4			4		
29	do	417	do	5			5		
29	do	413	do	6			6		
29	Wisconsin	190	do	4			4		
29	do	188	do	7			7		
29	do	186	do	6			6		
29	do	174	do	5		14	5	37	
88	Van Buren	416	do	8	8				
88	do	418	do	5	5				

88	Van Buren	420	Dwelling	5			5		
88	do	424	do	4	4				
88	Cass	413	do	3			3		
88	do	415	do	3			3		
88	do	417	do	6	6				
88	do	421	do	3			3		
88	Wisconsin	198	do	4	4				
88	do	200	do	6		27	6	20	
88	Wisconsin	204	Dwelling	4			4		
88	do	206	do	4			4		
88	do	210	do	10			10		
88	do	212	do	12	12				
88	do	214	do	8			8		
88	do	216	do	8			8		
88	do	218	do	7			7		
88	Mason	199	do	8			8		
88	do	213	do	Vacant.					Connected.
88	do	217	do	5			5		
88	do	219	do	6		12	6	50	
97	Cass	414	do	Vacant.					Connected.
97	do	416	do	6			6		
97	do	418	do	5			5		
97	do	420	do	Vacant.					Connected.
97	do	424	do	7			7		
97	do	422	do	8	8				
97	do	411	do	8	8				
97	do	417	Livery stable	3			8		Twenty-one horses.
97	do	419	Dwelling	Vacant.					Connected.
97	do	421	do	4			4		
97	do	420	do	4	4				
97	Mason	421	do	5			5		
97	do	429	do	8			8		
97	do	233	do	5			5		
97	do	237	do	5			5		
97	do	239	do	5			5		
97	Wisconsin	222	do	9			9		
97	do	234	do	5			5		
97	do	236	Saloon	6	6				
97	do	238	Dwelling	5			5		
97	do	240	do	10			10		
97	do	242	do	7			7		
97	do	244	do	5		26	5	94	
100	Marshall	408	do	6			6		
100	do	410	do	5	5				
100	do	412	do	7	7				
100	do	416	do	2	2				
100	do	418	do	5	5				
100	do	420	do	2	2				
196	do	226	do	7			7	58	Not connected.
100	Van Buren	422	do	Vacant.		21		6	
30	do	471	Academy	60			60		
30	do	463	Dwelling	4			4		Connected.

Table accompanying report of A. H. Scott, C. E., on Huron street sewer, Milwaukee, Wis.—Continued.

Number of block.	Name of street.	Street number.	Purpose of building.	Number of inhabitants.	Not connected.		Connected.		Remarks.
					Inhabitants.	Total inhabitants.	Inhabitants.	Total inhabitants.	
80	Van Buren	459	Dwelling	Vacant.					
80	do	455	do	8			8		
80	Mason	453	do	5			5		
80	do	192	do	7			7		
80	do	190	do	10			10		
80	Van Buren	176	do	8			8	102	
89	do	472	do	3			3		
89	do	468	do	3			3		
89	do	466	do	6			6		
89	do	464	do	5			5		
89	do	462	do	6			6		
80	do	458	do	6	6				
89	do	454	do	8			8		
89	Cass	448	do	8			8		
89	do	471	do	11	11				
89	do	469	do	8	8				
89	do	465	do	3	3				
89	do	461	do	3	3				
89	do	459	do	4	4				
89	Mason	453	do	6	6				
89	do	220	do	2	2				
89	do	214	do	4	4				
89	do	210	do	6	6				
89	do	208	do	5	5				
80	do	206	do	4	4				
89	Cass	198	do	4		62	4	43	
96	do	472	do	5			5		
96	do	460	do	6			6		
96	Marshall	450	do	8			6		
96	do	469	do	6			6		
96	do	467	do	5			5		
96	do	465	do	4			4		
96	do	459	do	6			6		
96	do	451	do	4			4		
96	do	449	do	5			5		
96	Mason	443	do	4			4		
101	Marshall	440	do	4			4		
101	do	460	do	7			7		
101	do	462	do	5			5		
101	do	464	do	5			5		

101	......do	466	......do	2			2		
101	......do	472	......do	5			5		
101	Mason	248	......do	10			10		
101	......do	258	......do	Vacant.					Connected.
101	Lake	450	......do	3	3	3		38	
	Totals			4,035		858		3,177	

SUMMARY.

Total population tributary to Huron street sewer (living in 368 buildings) 3,177
Total population possibly tributary to Huron street sewer (living in 500 buildings) 4,035

Table showing street numbers, uses, population, and connection or non-connection of building with the Market street subdistrict sewer, Poughkeepsie, N. Y., January 19, 1880.

Street number.	Number of families in houses.	Number of persons in houses.	Uses of building.	Population in houses connected with sewer.	Population in houses not connected with sewer.	Remarks.
MARKET STREET.						
69	1	9	Residence			Connected on Church street.
70			...do			Drains out of district.
81	2	10	...do	10		
82	1	3	...do	3		
86	1	3	...do	3		
89	1	6	...do			Connected on Noxon street.
85	1	9	...do			Do.
83	2	5	...do	5		
90	2	8	...do	8		
92	1	5	...do		5	
93	1	10	...do		10	Rear building.
93	2	10	...do	10		Front building.
96		40	School		40	Day-school.
100	1	4	Residence	4		
102			...do			Vacant; connected.
104	1	4	...do	4		
106	1	7	...do	7		
110	1	6	...do	6		
112	1	3	...do		3	
114	2	4	...do		4	
116	1	3	...do		3	
117	1	4	...do		4	
NOXON STREET.						
				6		See No. 89 Market street.
				9		See No. 85 Market street.
12			Stable			Not connected.
14	1	4	Residence		4	
16	1	6	...do		6	
17			...do			Vacant; not connected.
18	1	3	...do	3		
19	1	8	...do		8	
20	1	7	...do	7		
21	1	4	...do		4	
22	1	8	...do	8		
22½	1	2	...do		2	
23	1	3	...do		3	
24	1	3	...do		3	
25	1	4	...do		4	
26	1	7	...do	7		
30	1	6	...do		6	
31	1	7	...do	7		
32	1	6	...do		6	
33	2	8	...do	8		
34	1	5	...do	5		
39	1*	14	Boarding-house.	14		Washing of all done in house.
41	1	4	Residence	4		
43	1	7	...do	7		
46	2	5	...do		5	
47	1	4	...do		4	
48	2	7	...do		7	
50	1	3	...do		3	
51	1	4	...do		4	
52	1	2	...do	2		
54	2	4	...do	4		
55	1	7	...do	7		
56	1	5	...do	5		
57	1	1	...do	1		
	1	3	...do	3		Nmbered on Academy street.
CHURCH STREET.						
			Church.			Christ, Episcopal, not con.
			Residence	9		See No. 69 Market street.
176			Stable			Not connected.
178	2	8	Residence	8		
180	1	8	...do	8		
181			Stable			Connected.
182	1	7	Residence		7	

*And others.

Table showing street numbers, uses, population, &c.—Continued.

Street number.	Number of families in houses.	Number of persons in houses.	Uses of building.	Population in houses connected with sewer.	Population in houses *not* connected with sewer.	Remarks.
CHURCH STREET—continued.						
184	1	3	....do	......	3	
186	1	7	... do	......	7	
188	1	4	Carriage-shop	......	4	Employés.
193	1	5	Residence	......	5	
194	1	7	... do	......	7	
196	......	......	do	......	......	Vacant; not connected.
197	......	182	Public school No. 2	182	......	Day-scholars only.
198	......	......	Boarding-stable	......	......	Not connected.
200	1	2	Residence	......	2	
201	1	5	....do	......	5	Stable; vacant, and not con.
202	......	......	....do	......	......	Vacant; not connected.
203	2	10	... do	10	......	
205	1	10	... do	......	10	
206	1	5	....do	5	......	
207	1	3	... do	......	3	
208	3	14	....do	14	......	
207½	......	......	Stable	......	......	Not connected.
209	......	......	Residence	......	......	Vacant; connected.
210	2	7	....do	......	7	
212	......	......	....do	......	......	Vacant; connected.
214	......	......	....do	......	......	do
215	......	......	Stable	......	......	Not connected.
216	2	10	Residence	......	10	
219	2	7	....do	7	......	
220	2	6	....do	......	6	
221	2	8	....do	8	......	
222	1	3	....do	3	......	
......	1	5	....do	5	......	Numbered on Academy street.
RÉSUMÉ.						
Market street	24	153	......	60	69	
Noxon street	35	161	......	107	69	
Church street	31	326	......	259	76	
Total	90	640	......	426	214	

Total number of buildings possibly tributary to the sewer........ 87
Total number of buildings actually tributary to the sewer January 19, 1880........ 89

Table of measurements at the manhole, corner Pine and Chestnut streets, Providence, R. I., Monday, October 6, 1879, in the inverts of 12-inch sewer and 6-inch reducer.

Hour.	Depth of flow in 6-inch pipe.	Depth of flow in 12-inch pipe.	Remarks.
	Inches.	*Inches.*	
8.00 a. m	.7500	......	12-inch pipe not gauged.
8.15 a. m	Maximum, .8750	......	Do.
8.30 a. m	.3750	.3125	
8.45 a. m	.5000	Maximum, .4375	
9.00 a. m	.3125	.2500	
9.15 a. m	.3125	.2500	
9.30 a. m	.3125	.2500	
9.45 a. m	.5000	.3750	
10.00 a. m	.5000	.3750	
10.15 a. m	.5000	.3750	
10.30 a. m	Minimum, .2500	Minimum, .1875	
10.45 a. m	.3125	.2500	
11.00 a. m	.3750	.3125	
Sum	5.8750	3.3750	
Mean	0.4519	0.3068	

Table showing street numbers, uses, population, and connection or non-connection of buildings with the Pine street sewer, Providence, R. I., October 6, 1879.

Street number.	Number of families in houses.	Number of persons in houses.	Uses of building.	Population in houses connected with sewer.	Population in houses not connected with sewer.	Remarks.
218	2	10	Residence	10	......	
222	....	1	Grocery	......	1	
226	Vacant.	Vacant.	Residence	......	......	Vacant; connected with sewer.
240	2	7	......do	......	7	
242	2	6	......do	6	......	
	4	10	......do	......	10	House not numbered.
258	2	7	......do	......	7	
262	2	6	......do	......	6	
266	2	8	......do	8	......	
270	1	9	......do	9	......	
276	Vacant.	Vacant.	......do	......	......	Vacant; connected with sewer.
280	2	7	......do	7	......	
282	1	5	......do	5	......	
288	1	2	......do	2	......	
290	‡1	10	Boarding-house	10	......	Washing of seven persons not done here.
298	2	6	Residence	......	6	
300	1	7	......do	7	......	
304	1	8	......do	8	......	
306	‡1	8	Boarding-house	8	......	Washing of five persons not done here.
310	2	5	Residence	5	......	
322	2	10	......do	10	......	
328	1	4	......do	......	4	
332	2	9	......do	9	......	
336	1	5	......do	......	5	
340	2	11	......do	......	11	
346	1	6	......do	6	......	
33	4	10	......do	10	......	No. 33 Chestnut; not numbered on Pine.
221	1	2	......do	......	2	
225	2	7	......do	7	......	
229	2	12	......do	......	12	
235	2	5	......do	5	......	
	2	7	......do	7	......	No. 17 Gould Lane.
239	2	6	......do	6	......	
247	1	5	......do	......	5	
253	2	8	......do	8	......	
	2	6	......do	6	......	No. 20 Claverick street.
261	2	8	......do	8	......	
265	2	9	......do	......	9	
271*	....	....	......do	......	......	Not connected.
275	2	8	......do	8	......	
279	2	8	......do	8	......	
281	2	7	......do	7	......	
285	1	7	......do	7	......	
289	2	6	......do	6	......	
301†	2	11	......do	11	......	
305	....	1	Shoe-shop	......	1	
309	1	8	House and meat-shop	8	......	
311	1	7	House and barber-shop	......	7	
317	2	6	House and laundry	......	6	
319	1	3	Residence	3	......	
321	2	7	......do	7	......	
325	Vacant.	Vacant.	Stores	......	......	Vacant; connected with sewer.
327	2	4	Residence	4	......	
	2	10	......do	10	......	Back of 327; no number.
329	1	6	......do	6	......	
335	1	4	......do	4	......	
337	1	10	......do	10	......	
339	2	6	......do	6	......	
Total	89	366		267	99	

* No answer to bell. † Soap factory in rear; connected, but not discharging October 8, 1879. ‡ And others.

Total number of buildings possibly tributary to the Pine-street sewer 60
Total number of buildings actually tributary to the Pine-street sewer, October 6, 1879 41

Diameters of sewers capable of discharging 50 gallons per front foot, or 1,250 gallons per house (25 front feet), per day, when running three-fourths full.

Number of front feet.	Fall of sewer per 100 feet.																	Number of houses.
	.2	.4	.6	.8	1.0	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	
	Diameter in feet.																	
100	.124	.108	.100	.094	.090	.086	.083	.081	.078	.077	.075	.074	.072	.071	.070	.069	.068	4
200	.164	.143	.132	.124	.119	.114	.110	.106	.103	.101	.099	.097	.095	.094	.093	.091	.090	8
300	.193	.168	.135	.146	.140	.134	.129	.125	.122	.119	.116	.114	.112	.110	.109	.107	.106	12
400	.216	.188	.174	.164	.157	.150	.145	.140	.137	.133	.131	.128	.126	.124	.122	.120	.119	16
500	.237	.206	.190	.179	.172	.164	.158	.153	.149	.146	.143	.140	.138	.135	.133	.132	.130	20
600	.255	.222	.204	.193	.184	.176	.170	.165	.161	.157	.154	.151	.148	.146	.144	.142	.140	24
700	.271	.236	.217	.205	.196	.188	.181	.175	.171	.107	.163	.160	.158	.155	.153	.151	.149	28
800	.286	.247	.229	.216	.207	.197	.191	.185	.180	.176	.172	.169	.166	.164	.161	.159	.157	33
900	.299	.261	.240	.227	.217	.207	.200	194	.189	.184	.181	.177	.174	.171	.169	.167	.164	36
1,000	.312	.272	.251	.237	.226	.216	.209	.203	.197	.192	.188	.185	.182	.179	.176	.174	.171	40
2,000	.412	.359	.331	.312	.299	.286	.275	.267	.260	.254	.249	.244	.240	.236	.232	.229	.226	80
3,000	.485	.422	.389	.367	.351	.336	.324	.314	.306	.299	.292	.287	.282	.277	.273	.270	.266	120
4,000	.544	.473	.437	.412	.392	.377	.363	.352	.343	.335	.328	.322	.316	.311	.307	.302	.299	160
5,000	.594	.522	.477	.450	.431	.412	.397	.385	.375	.366	.359	.353	.346	.340	.335	.331	.326	200
6,000	.639	.557	.513	.485	.463	.443	.427	.414	.403	.394	.386	.378	.372	.366	.361	.356	.351	240
7,000	.680	.592	.546	.515	.493	.471	.454	.441	.429	.419	.410	.403	.396	.389	.384	.378	.874	280
8,000	.717	.624	.576	.544	.520	.497	.479	.465	.453	.442	.433	.425	.417	.411	.405	.399	.394	320
9,000	.752	.655	.604	.570	.545	.521	.503	.487	.474	.463	.464	.445	.437	.431	.424	.418	.413	360
10,000	.784	.683	.630	.594	.568	.544	.524	.508	.495	.483	.473	.464	.456	.449	.442	.436	.431	400
20,000	1.035	.901	.831	.784	.750	.717	.692	.671	.653	.638	.624	.613	.602	.593	.584	.576	.568	800
30,000	1.217	1.060	.977	.922	.882	.844	.813	.789	.768	.750	.734	.721	.708	.697	.687	.677	.668	1,200
40,000	1.365	1.1[illegible]9	1.096	1.035	.990	.946	.913	.885	.862	.841	.824	.808	.794	.782	.770	.760	.750	1,600
50,000	1.493	1.312	1.198	1.131	1.083	1.035	.998	.967	.942	.920	.901	.884	.869	.855	.842	.831	.820	2,000
60,000	1.606	1.398	1.289	1.217	1.164	1.113	1.073	1.041	1.013	.990	.969	.951	.934	.919	.906	.894	.882	2,400
70,000	1.708	1.487	1.371	1.294	1.238	1.184	1.142	1.107	1.078	1.053	1.031	1.011	.994	.978	.964	.950	.938	2,800
80,000	1.802	1.569	1.446	1.306	1.306	1.249	1.204	1.168	1.137	1.110	1.087	1.067	1.048	1.032	1.017	1.003	.990	3,200
90,000	1.889	1.644	1.516	1.431	1.366	1.309	1.262	1.224	1.192	1.164	1.140	1.118	1.099	1.081	1.066	1.051	1.037	3,600
100,000	1.970	1.715	1.581	1.493	1.428	1.366	1.317	1.277	1.243	1.214	1.189	1.166	1.146	1.128	1.111	1.096	1.082	4,000

FORMULA.

$d=\left(\frac{n^2}{h}\times \log.^{-1} 0.7732933-10\right)^{\frac{1}{5}}=\frac{1}{70}\left(\frac{n^2}{h}\right)^{\frac{1}{5}}$ d = diameter in feet, n = number of front feet, h = fall per 100 feet.

ROBT. MOORE,
Sewer Commissioner.

SAINT LOUIS, *April* 8, 1880.

APPENDIX G.

REPORT UPON THE EFFECT OF INOCULATING THE LOWER ANIMALS WITH DIPHTHERITIC EXUDATION.

BY DRS. H. C. WOOD AND HENRY F. FORMAD.

The object of the research which we have the honor to report to your board was to determine whether it is possible to produce diphtheria in the lower animals by the inoculation of the exudations from diseased human subjects. The experimental results and theories promulgated by Oertel, Trendelenburg, and others are so well known that we shall give no detailed references to them, but confine ourselves to our own experimental researches and the discussion of essential facts. There can be no doubt that animals not rarely die of pseudo-membranous affections offering symptoms similar to those of diphtheria in man. An epidemic of such disorder amongst rabbits will be spoken of later from our own experience. It is, however, by no means certain that these pseudo-membranous affections in the lower animals are the same as the human disorder. In attempting the systematic investigation of the subject our first series of experiments were made to determine the effects of inoculating animals with membrane taken from persons sick with diphtheria. The poison was put in little pockets made with a lancet under the skin, or inoculated by scarification in the mucous membrane of the mouth; in many instances both methods were simultaneously practiced; unless otherwise stated, no antiseptics had been used on throat near the time of taking away the membrane.

There are recorded in the table first given thirty-two experiments, in only six of which the animals died, unless killed accidentally or otherwise. The time between the dates of death and of the last inoculation was, Experiment IV, six days; Experiment VI, seventy hours; Experiment XI, fifteen days; Experiment XVI, eleven days; Experiment XXIII, thirteen days; Experiment XXV, two days. The question naturally arises as to whether the few animals in which the inoculation was followed by death died of diphtheria or of some other disease. There is only one sign which can be considered pathognomonic of the diphtheritic process, namely, the formation of false membrane in various parts of the body; and it is to be noted that only in one case were there any exudations present in any organ which could give rise to the slightest suspicion that the animal died from diphtheria. In this case, Experiment XVI, there was only an indication of exudation upon the trachea, which, while it may have been due simply to a catarrhal inflammation, presents some of the characteristics of false membrane. A microscopic specimen of this, Experiment A, page 385.

It has been asserted by Oertel that animals which have been inoculated with diphtheritic material die with their internal organs infested with micrococci, and that the presence of these is characteristic of diphtheria. We have carefully examined the internal organs of the rabbits which died, as well as the blood of those which survived, and found no micrococci. In this our results are in complete accord with the very careful labors of Curtis and Satterthwaite.

The utmost care is necessary to prevent the entrance into the blood of bacteria, from without. Thus, we have cut the jugular vein of a rabbit and, examining the blood at once, found it entirely free from bacteria. When, however, after the lapse of a few minutes the post mortem was concluded and the heart opened, the blood therein contained possessed an abundance of these low organisms.

It will hereafter be shown that micrococci indistinguishable from those of diphtheria are abundant in the false membrane produced traumatically in the trachea of rabbits, and we therefore conclude that these organisms are at least not characteristic of diphtheria. If they be so, however, we must conclude that none of the animals which we inoculated took the disease, since no bacteria or micrococci were present except in the lungs, upon whose surface they may often be met with in animals which certainly have not been infected with diphtheria.

If our animals did not die of diphtheria, of what did they die? A study of the post-mortem reports will show that in every case the internal organs were tubercular, and in many cases intensely so; also, that tubercular disease was found in the organs of rabbits which were killed some days after inoculation. It is therefore a very natural belief that in those cases in which death was long delayed it was due to tuberculosis. It certainly is very possible that when death takes place soon after inoculation it may be the result of a non-specific blood poisoning, and not of diphtheria. In the experiments of Curtis and Satterthwaite, death not rarely occurred in a very brief time; with us it was almost always very long delayed. The difference may have been from

our using smaller portions of the diphtheritic material and inoculating less deeply than did those gentlemen. It is, perhaps, proper to call attention to the fact that in no case did inoculation in the mouth produce either local or general symptoms.

In order to discover whether the diphtheritic exudation acted specifically in the production of tubercle, or whether it merely set up a local inflammation which formed a focus of infection, we experimented by putting under the skin of rabbits small masses of innocuous foreign matters.

It will be seen that in five out of nine of these experiments tubercle was found after death; this large proportion apparently demonstrates that a simple local inflammation may in the rabbit act as a source of tubercular infection. Now, in our experiments, as in those of Drs. Curtis and Satterthwaite, where diptheritic matter was inoculated, inflammation was almost always induced at the seat of the lesion, with the formation of large lumps containing cheesy matter. These facts being so, it is a fair deduction that the tubercles were secondary to these inflammatory foci, and were therefore an indirect and not a direct result of the inoculation. We believe, therefore, that diphtheritic membrane placed under the skin or in the muscles of rabbits may cause death in a few hours by the production of a blood poisoning, which is not accompanied by any specific symptoms or lesions, or, after many days, by the development of a secondary tuberculosis.

The method by which Trendelenburg asserts that he succeeded in producing diphtheria in rabbits consists in placing the exudation matter in the trachea. As our experiments have led us to attach no importance to micrococci as a test of diphtheria, we naturally have suspected that the membrane when placed in the trachea produces simply a trachitis. This suspicion has been strengthened by the observation that acute pseudo-membranous trachitis and angina seem to occur in rabbits. Such an epidemic destroyed during the last winter a number of rabbits kept by one of us in a perfectly clean place. The rabbits first showed sickness by refusing food; examination then detected swelling of the tonsils with exudation upon them. There was high fever with increase of the local symtoms until the animals became entirely unable to swallow. Death occurred in from three to seven days, preceded by great difficulty of breathing and profound exhaustion. False membrane was abundant in the mouth and trachea. It showed on examination all the characteristics of diphtheria exudation. If it meets the approbation of the National Board, we would like during the coming winter to determine experimentally whether it is not possible to produce at will such diphtheria-like epidemics; and also how far contagion has to do with the spread of the disorder.

The next series of experiments were undertaken to determine the correctness of the assertion of Trendelenburg that the introduction of pseudo-membrane into the trachea produces diphtheria. Unfortunately, owing to the coming on of warm weather, we have been unable to obtain a sufficient supply of exudation to test the subject fully, but it will be seen that in one of the four experiments made with dried exudation pseudo-membranous trachitis was produced. So that Trendelenburg's assertions, which have also been confirmed by Oertel, seem to be correct. But we do not feel that our experiments have as yet been sufficient to enable us to speak positively from personal knowledge.

As stated by Professor Oertel and other observers, the injection of certain corrosives will produce in the rabbit pseudo-membranous trachitis.

Our next series of experiments were performed to determine whether such production is possible in other animals than the rabbit, and also whether the membrane thus obtained resembles that occurring spontaneously or produced by the introduction of diphtheritic matter into the trachea.

The experiments which are recorded in the last table show that ammonia is able to produce in the cat and dog, as well as in the rabbit, a pseudo-membranous trachitis. Professor Oertel states that the membrane produced by canterization of the trachea differs from diphtheritic membrane in containing no bacteria. What has led him to such an assertion, we cannot comprehend. When the death occurred very quickly bacteria and micrococci may have been less abundant in the traumatic membrane than in that taken from the throat of patients, but when the animal survived some days and the bacteria had sufficient time to develop themselves—when, in other words, they were afforded as good opportunity of growth as in the natural disease—they were immensely abundant, in some cases seeming to make up a large part of the bulk of the membrane.

If it be possible to produce a fatal pseudo-membranous trachitis by placing the diptheritic membrane in the trachea, and not possible to cause septicæmia by inoculating other portions of the body with the same material, it would appear as though diphtheria might be originally a local disease with a subsequent septic poisoning. The scope for investigation here opened is very great; on account of the lack of time, we have not attempted, at present, to answer fully the questions which arise; we have, however, performed a number of experiments to determine whether any products of disease other than diptheritic exudations are capable of causing pseudo-membranous trachitis.

FIRST SERIES OF EXPERIMENTS.

Inoculation of diphtheritic matter subcutaneously and in the mucous membrane of the mouth.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of post mortem, and of microscopic examination.	Remarks chiefly upon source of matter employed.
1	Apr. 22	Small rabbit, No. 1.	Inoculated on tongue with fresh diphtheritic membrane.	Remained perfectly well to May 16, 24 days, when they were accidentally killed.	No signs of diphtheritic inflammation anywhere. The spleen, lymph, glands, liver, and lung showed some tubercle granulations. The rest of the organs normal. No bacteria in the organs.	Case I.—Material taken by Dr. Cardeza from child, 3 hours previously to inoculation. Child's throat had been touched with tincture of iron and glycerine previously.
2	Apr. 23	Small rabbit, No. 2.	Same as last			
3	Apr. 24	Small rabbit, No. 3.	Same as last	Remained well		Same case. The throat for 24 hours previous to the removal had not been touched by anything.
4	Apr. 24	Small rabbit, No. 4.	Same as last	Died May 10	No lesions except lymphatic glands swollen and tuberculous; also spleen. No bacteria in organs.	Same case and exudation as last.
5	Apr. 24	Large gray rabbit, No. 5.	Inoculated in mouth; had also a piece of membrane put under the skin of the side.	May 4, was feverish for several days; a hard lump developed on the side at the seat of inoculation consisting of cheesy matter. June 6, animal well, cheesy lump smaller but persistent. Animal remained well.	Cheesy matter composed of pus, compound granule cells, debris, and numerous bacteria.	Same case. The child recovered from the acute attack, which was followed by paralysis, finally resulting in death.
6	Apr. 29	Small albino rabbit, No. 6.	Inoculated with fresh diphtheritic membrane in mouth, tongue, roof, and pharynx, and also subcutaneously on thigh.	Died May 2, 70 hours after inoculation, in convulsions, which commenced 6 hours previous to death.	Small cheesy lump at the seat of subcutaneous inoculation. Tongue ulcerated; no signs of diphtheritic inflammation anywhere; all organs hyperæmic, otherwise of normal appearance, but upon microscopic examination tubercular granulations well marked in lung, liver, spleen, and lymphatic glands. No bacteria in organs except lungs, where are also hemorrhagic infarctions.	Case II.—Removed by Dr. Dunmire from the throat of child a few hours previously.
7	Apr. 29	Small albino rabbit, No. 7.	Same as last	Animal remained well		Same case.

8	Apr. 29	Small rabbit, No. 8	Same as last	Remained well to May 1, when killed accidentally.	Post mortem revealed no lesions.	Case III.—From Dr. Cardesa; inoculation made 15 minutes after removal of the membrane from the child's throat. This case was in same family as No. 1, and originally apparently contagious.
9	Apr. 29	Small rabbit, No. 9.	Same as last	Remained well to May 16, when accidentally killed.		
10	Apr. 29	Albino rabbit, middle-sized, No. 10.	Same as last	Remained well.		
11	Apr. 30	Rabbit, No. 3	Re-inoculated with diphtheritic matter in mouth and subcutaneously. May 7, inoculated third time.	Remained well up to May 13; found dead May 14.	Small cheesy lump on thigh at the place of inoculation. All organs tubercular, otherwise to the naked eye of normal appearance. No bacteria in organs.	Case IV.—From Dr. James Collins, twelfth day of disease. Matter semi-liquid, mixed with blood. The case afterward died.
12	Apr. 30	Dog, No. 1	Inoculated with diphtheritic membrane in mouth and thigh.	Remained well		Same case.
13	Apr. 30	Large cat, No. 1	Inoculated with diphtheritic matter in mouth and subcutaneously on right thigh.	Remained well; a large lump developed in skin at seat of inoculation, which eventually disappeared. No micrococci in blood.		Case IV.—From Dr. Collins. Case recovered.
14	Apr. 30	Rabbit, No. 11, large albino.	Same as last.			
15	Apr. 30	Rabbit, No. 12, large old albino.	Same as last	Remained well.		
16	May 1	Small rabbit, No. 13.	Same as last	A small cheesy lump developed at seat of inoculation; died May 12.	Slight exudation on the mucous membrane of the larynx and trachea, of grayish color and translucent. Trachea and lungs much congested. All organs tubercular; in the lungs are seen profuse hemorrhagic infarctions, and numerous bacteria. No bacteria in the organs.	Case V.—From Dr. W. S. Stewart. Membrane inoculated fresh on the day of removal.
17	May 1	Large cat, No. 2	Same as former	Remained well; lump developed on side and disappeared within a week, healing perfectly. No micrococci in blood.		Same case.
18	May 1	Small cat, No. 3	Inoculated in mouth	Remained well		Same case.
19	May 1	Dog, No. 2	Inoculated in mouth, pharynx, tonsils, tongue, and also subcutaneously on the side, with fresh diptheritic matter. The latter also given to the animal mixed with food.	Remained well. Killed June 11.	Cheesy lump which had existed for a long while on the side found to have been absorbed; in its place found a hard lump, probably of cicatricial tissue. No lesions perceptible. Blood examined during life did not show any bacteria.	
20	May 4	Small cat, No. 4	Inoculated with dried diphtheritic matter in mouth and subcutaneously.	Remained well. Killed June 12.	No lesions found; blood did not contain bacteria.	Case VI.—From Dr. Frank R. Brunner. Membrane removed several days ago from woman of 45 years; apparently much decomposed.

FIRST SERIES OF EXPERIMENTS.

Inoculation of diptheritic matter, &c.—Continued.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
21	May 4	Large rabbit, No. 14.	Same as in last experimemt	Remained well. Has large lump at place of skin inoculation.	No lesions except a large cheesy lump on side. No microscopic examination made.	
22	May 4	Cat, No. 5	Same as last	Remained well. Killed June 12.	Large cheesy lump at the place of subcutaneous inoculation; no signs of diphtheritic inflammation; lungs highly congested, the remaining organs all appearing normal to the naked eye; but microscopic examination showed tubercular granulations everywhere; hemorrhagic infarctions in lungs; no bacteria in organs except lungs.	Case VII.—From Dr. Collins.
23	May 7	Large rabbit, No. 15.	Same as last	Remained well up to May 19. Found dead May 20.		
24	May 7	Small rabbit, No. 9	Reinoculated with fresh diphtheritic matter in mouth and subcutaneously.	Killed accidentally	Post mortem revealed no lesion	See experiment 9.
25	May 7	Small rabbit, No. 3.	Inoculated the third time as before with fresh matter.	Died May 9	A small cheesy lump on thigh at the place of inoculation; all organs tubercular, otherwise to the naked eye of normal appearance; no bacteria in organs.	
26	May 9	Dog, No. 3	Inoculated in month and skin with fresh membrane.	Remained well		Case VIII.—From Dr. James Collins.
27	May 9	Small cat, No. 6.				
28	May 9	Small cat, No. 7.	Same as the last	Remained well. Killed June 12	All had cicatrizing lump at place of skin inoculation; no other lesions detected; no bacteria in blood.	From Dr. James Collins.
29	May 9	Small cat, No. 8.				
30	May 11	Goat, No. 1	Inoculated in mouth and subcutaneously with fresh membrane.	Remained well		Case IX.—From Dr. H. C. Wood. Taken from a case the second day of the disease, the attack having been derived by contagion from the cases of Dr. Cardeza.
31	May 11	Cat, No. 9	Similar inoculation	Remained well.		
32	May 11	Cat, No. 10	Same as before	Found dead June 11	No microscopic examination made; specimen preserved.	

SECOND SERIES OF EXPERIMENTS.

Inoculation of foreign bodies subcutaneously.

33	Apr. 19	Small rabbit, No. 16.	A piece of wood, fragment of a match, put below the skin in the posterior part of the neck and the wound closed by a suture.	Wound healed rapidly, but subsequently a small lump of cheesy matter was formed. The animal was feverish for several days. In the lapse of two weeks the lump disappeared, and the animal remained well to date, June 8.	....	The foreign bodies used here have been before the experiments thoroughly washed and cleaned.
34	Apr. 22	Small albino rabbit, No. 17.	Treated similarly	Wound healed rapidly, but within a few days a large lump formed; ulceration set in, and cheesy matter protruded from wound; animal became emaciated, feverish. Died May 13.	All organs appeared hyperæmic; liver contains several small abscesses and numerous small nodules, the latter also seen in lung and spleen; lymphatic glands swollen; microscopic examination revealed large collections of tubercle granulations in all organs; the proportion of white blood corpuscle increased; no bacteria in blood.	
35	Apr. 22	Small rabbit, No. 18.	A piece of clean glass put below the skin in the right thigh; wound closed.	Result similar to last, only slower. Died May 20.	Lesions similar to the last, but slighter in degree; hemorrhagic infarctions in lungs very marked.	
36	Apr. 25	Large albino rabbit, No. 19.	A piece of glass put deep below the skin in the right thigh; wound closed.	Wound healed at first, then severe ulceration set in, cheesy matter protruding from wound; the latter increased to four times the original size. Died May 10.	No decided lesions to the naked eye; microscopic examination showed all organs to be profusely tubercular; hemorrhagic infarctions in the lungs; echinococci cysts in the liver; no bacteria in the organs.	
37	Apr. 25	Albino rabbit, No. 20.	Treated similarly			
38	Apr. 25	Small rabbit, No. 21.	Treated similarily with a piece of cork.	Wound healed after slight suppuration. Animals remain well.		
39	Apr. 25	Small rabbit, No. 22.	Treated similarly with a small bunch of clean hair.			
40	May 6	Small rabbit, No. 23.	A piece of wood, fragment of a match, put deep below the skin in the right thigh.	Cheesy lump formed rapidly and protruded from wound. Died May 19.	All organs showed masses of tubercle granulations; no other decided lesions; no bacteria in the organs.	
41	May 6	Small rabbit, No. 24.	A piece of wire put below skin in the left thigh.	Cheesy lump formed; the wire ulcerated away. Died May 15.	Hemorrhagic infarctions in lungs; tubercle granulations everywhere, although not very marked; no bacteria in the organs; none in the blood.	

THIRD SERIES OF EXPERIMENTS.

Inoculation with diphtheretic matter in the trachea.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
42	May 31.	Large albino rabbit, No. 27. Fresh rabbit.	Inoculated with dried diphtheritic matter, mixed with water, in the trachea, from without.	Still alive and well, June 20	....	Case X.—Of diptheria, received through Dr. Jaggard, about 24 hours after removal. The membrane dry and hard; apparently in perfect condition.
43	June 1.	Albino rabbit, No. 10. See experiment 10.	Same as last	Died June 6, five days after inoculation, in convulsions.	External wound had healed perfectly; some ecchymosis noticeable, and the subcutaneous tissue infiltrated and congested. The wound in the trachea did not quite heal; larynx and trachea are congested and covered by a delicate true pseudo-membrane, which reaches, near the larynx, a thickness of 1mm. Microscopically, it also appears fully identical with the natural and with the ammonia false membrane, containing micrococci in large number. No bacteria in blood, none in organs. The organs are tubercular, more especially the liver, where large nodules can be seen even by the naked eye. No hyperæmia of organs, as in the ammonia specimen.	Same case.
44	June 14.	Young albino rabbit, No. 37.	Inoculated with dried diphtheritic matter, mixed with water, in the trachea.	June 18. Evening. Animals apparently well; take food, &c.; breathing not much interfered with. The same evening killed rabbit 37; No. 38 was found dead June 19.	No lesions; no bacteria in blood, which was very carefully examined.	Case II.—Diphtheritic matter taken by Dr. Richard A. Cleeman from throat of patient untouched; inoculation about 36 hours after membrane was taken; it was dried quickly and was in good condition.
45	June 14.	Young albino rabbit, No. 38.	Same as last		No lesion; blood not examined.	Same as last.

FOURTH SERIES OF EXPERIMENTS.

Injection of ammonia into the trachea.

46	May 15, 4 p. m.	Large albino rabbit, No. 11.	Injected three or four drops of aqua ammonia into the trachea from without, the trachea being laid bare and a small opening cut into it.	Died May 18, 1 p. m., in convulsions, 69 hours after inoculation. During sickness breathing of the animal was extremely affected, very forced, deep, the rabbit opening the mouth widely at each straining effort, and raising the head; did not take food except the last twelve hours before death, when he seemed to feel easier.	Wound in skin and muscles covering the trachea was suppurating; tracheal wound had healed. All organs strongly hyperæmic, and tubercular nodules recognizable by naked eye. On opening the larynx and trachea, a well-developed pseudo-membrane of 1 to 3 mm. in thickness was seen, which reached below the bifurcation and into the smaller bronchio. It resembles fully in color, consistency, and easiness of detachment, the natural croupous membrane, and is perfectly identical with the latter upon microscopic examination. Bacteria are abundant, both in spheres and disseminated; none in internal organs except the lungs. Tubercles most prominent in the lungs, spleen, and lymphatic glands. Hemorrhagic infarction in lungs.
47	May 15, 4 p. m.	Large albino rabbit, No. 12, about 4 years old.	Treated with ammopia similarly to the foregoing.	Died May 18, 4 p. m., 73 hours after inoculation. Animal seemed not to suffer and took food well; death in convulsions, which lasted about 3 hours.	External wound as well as that of the trachea had perfectly healed. Lesions perfectly similar to those of foregoing rabbit only less intense in degree. Tubercles more scarce; lungs less hyperæmic and less infarcted. No micrococci in blood; pseudo-membrane fully developed and perfectly similar to foregoing. Bacteria and micrococci present in membrane and in lungs, but none in other organs.
48	May 28, 12 o'ck.	Albino rabbit, No. 7.	Treated with ammonia like foregoing rabbits, Experiments 46 and 48.	Died May 30, 11 a. m., 71 hours after operation.	Lesions fully indentical with last rabbit, Experiment 47.
49	May 28, 12 o'ck.	Cat, No. 7.	Same as last experiments, 46, 47, and 48.	Died May 30, 2 p. m., 50 hours after operation.	Lesions and well-developed false membrane similar to those in the last three rabbits, but here absence of tubercles. No micrococci in blood, and none in organs.

FOURTH SERIES OF EXPERIMENTS.

Injection of ammonia into the trachea—Continued.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examinations.	Remarks.
50	May 28, 12 o'ck.	Dog, No. 3.	Same as last	Great difficulty of breathing and inability to swallow followed the operation, but animal was artificially fed with milk, &c.; 12 days after the operation seemd to be recovering; killed June 9.	Body much emaciated; skin wound healed, while tracheal wound was open yet; slight congestion of tissues around trachea. In many places on the mucous membrane of trachea traces of disappearing false membrane seen; whole trachea coverered by thick tenaceous mucus containing large quantity of leucocytes, some giant cells, and bacteria in moderate quantity. Spleen highly tubercular, tubercles in liver, lymphatic glands, and some in lungs. No bacteria in blood taken from jugular vein immediately after death.	
51	June 8, 4.30 p. m.	Fresh rabbit, No. 25, about three months old.	Treated with ammonia similarly to the foregoing five experiments, 46, 47, 48, 49, 50.	Died June 9, 4 p. m.; no convulsions.	Autopsy made immediately after death. Wound in skin healed; tracheal wound open; the tissues around the latter strongly hyperæmic; trachea nearly filled by false membrane. A tested preparation of membrane taken five minutes after death showed the usual elements of a natural diphtheritic membrane with great abundance of bacteria; the blood did not contain bacteria. Lungs much congested; its vesicles largely filled with the crupous exudation, blood corpuscles, and bacteria. All other organs normal and not containimg bacteria.	
52	June 8, 4.30 p. m.	Rabbit, No. 26.	Same as last	Died from effect of operation, too much ammonia having been given.		

FIFTH SERIES OF EXPERIMENTS.

Inoculation with foreign bodies, pus, &c., in the trachea.

53	May 19	Large rabbit, No. 14. See Experiment 21.	Inoculated in the trachea with slough from a bed sore.	Wound healed rapidly, the animal recovering completely.		
54	June 3	Small rabbit, No. 28. Fresh rabbit.	Inoculated in the trachea and in the thigh muscels with exudation from throat of a scarlet fever patient.	Died June 12	Large cheesy lump on thigh. Some congestion and translucent mucus around tracheal wound which had not healed; no false membrane. No lesions in the organs; not examined for bacteria.	Case X.—From Dr. Fulton, the matter being produce of ulceration of a scarletinal sore throat.
55	June 3	Small rabbit, No. 29.	Inoculated in the trachea only with the same matter as last.	Died June 10	Skin wound healed; upon dissection a cheesy abscess found below subcutaneous tissue, pressing upon the trachea, and probably having been the cause of death. No other lesions perceptible. No bacteria in blood. None in organs.	
56	June 8	Small rabbit, No. 30.	Inoculated in trachea with the pseudo-membrane produced by ammonia in rabbit No. 25, Experiment 49.	Animal well June 18.		
57	June 8	Small rabbit, No. 31.	Same as last	Killed June 16	No lesions except congestions of trachea and large cheesy lump between the trachea and skin.	
58	June 8	Small rabbit, No. 32.	Inoculated in trachea with purulent mucus taken from trachea of dog No. 3, Experiment 48.	Died June 11	No lesions in any organ perceptible; tracheal wound not healed. No bacteria in blood.	
59	June 9	Large rabbit, No. 33.	Inoculated with ichorous pus in trachea.	Animal well		
60	June 10	Small rabbit, No. 34.	Inoculated with pus in trachea.	Found dead June 11	No lesions except congestion of trachea.	
61	June 10	Small rabbit, No. 35.	Same as last	Died June 18	Large cheesy lump between skin and trachea. Wound in trachea not healed; on opening the trachea a distinct pseudo-membrane of from 1 to 1½ millimeters in thickness was found, prominently seen only below the tracheal wound, i. e., in the lower half of the trachea and the bifurcation. Microscopically, this membrane was identical with the natural diphtheritic membrane and with those produced by introduction of ammonia, and of diphtheritic matter in the trachea.	

FIFTH SERIES OF EXPERIMENTS.

Inoculation with foreign bodies, pus, &c., in the trachea—Continued.

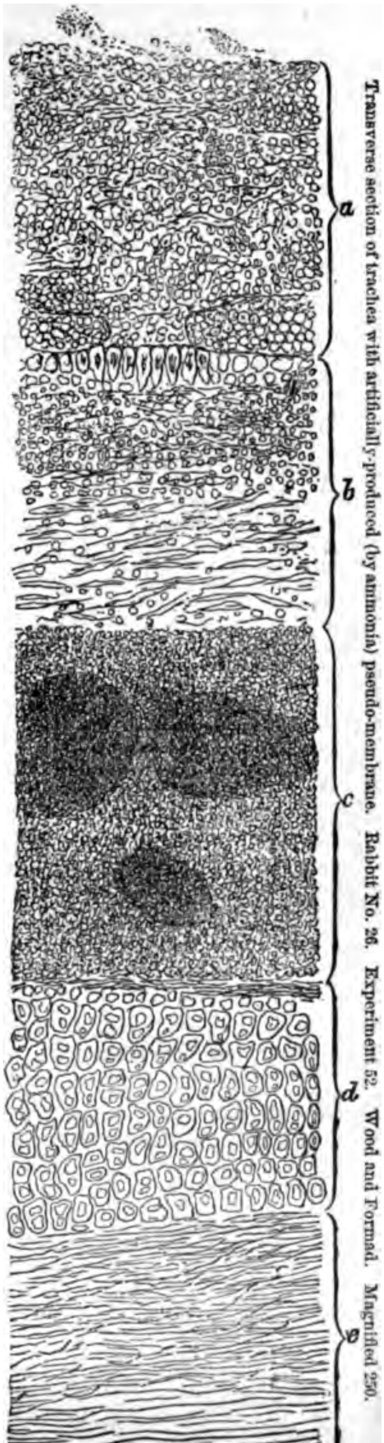
Number of experiment.	Date.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
62	June 10	Small rabbit, No. 36.	Inoculated with ichorous pus in trachea, and also deep in muscle.	Died June 17	Bacteria in large quantity all over. Cheesy abscess was found in the left lung; many air vesicles of both lungs filled with a croupous exudation containing multitudes of bacteria, prominent miliary tubercle in all organs. No bacteria in the kidneys; blood not examined. Large cheesy lump upon trachea, the latter much congested. Within the trachea a very distinct pseudo-membrane was developed in the lower half, like in last experiment and of the same mecroscopic and microscopic character. Croupous inflammation of lungs. Other organs normal.	

In looking over the last table, it will be seen that in two of the ten experiments pseudo-membranous trachitis was caused by the introduction of organic matter into the trachea. In both of the cases in which false membrane was produced the injected material was pus; and it will be noticed that only four such experiments were made, so that the proportion of successful result is very large, much larger indeed than with true diphtheritic exudation in our experiments.

Trendelenburg found that not only ammonia, but also various other chemical irritants are capable of causing the formation of false membrane in the trachea; many years since it was proven that tincture of cantharides will do the same thing. It would seem, therefore, that in the trachea the fromation of a pseudo-membrane is not the result of any peculiar or specific process, but simply of an intense inflammation, an inflammation which may be produced by any irritant of sufficient power. This fact, certainly, is very suggestive in regard to the pathology of diphtheria, and whilst we are not prepared to commit ourselves to any theory, it does seem proper to call attention to certain facts as indicating a very simple explanation of the peculiarities of the disease.

It is certain that as in the lower animals, so also in man, will chemical irritants produce a pseudo-membranous trachitis; we are also well assured that there is no anatomical difference which can be detected with the microscope between the lesions of true croup and diphtheritic angina. A difference has been believed by some pathologists to exist between the two diseases, in that in croup the membrane separates easily; in diphtheria with great difficulty from mucous membrane. This seems to arise from a misunderstanding. The mucous membrane of the fauces and mouth has a squamous not easily detached epithelium, and consequently membrane connected with or springing from such surface is firmly adherent. The epithelium of the trachea is columnar, ciliated, and detaches with the utmost facility even in normal condition of the organ; hence membrane attached to it separates readily. The membrane of diphtheritic trachitis is always readily detached in the line of the epithelium. Our preparations also show that the exudation of the croupous inflammation excited artificially in the trachea is not merely superficial, but also extends below the basement membrane. Some of the best clinical authorities of the day teach that there is no essential clinical difference between true croup and diphtheria, cases commencing apparently as local sthenic inflammation and ending as the typical adynamic systemic poisoning. Every practitioner must have seen cases of angina in which he was in doubt whether to call the affection diphtheria or not; the very frequent diagnosis of

a. Superficial pseudo-membrane. *b.* Croupous exudate below basement membrane. Between *a* and *b* are seen some remains of surface epithelium. *c.* Ecchymosis in submucous tissue and infiltration of tracheal glands with blood corpuscles. *d.* Cartilage. *e.* Outer connecting tissue and muscular investment.



Transverse section of trachea with artificially-produced (by ammonia) pseudo-membrane. Rabbit No. 26. Experiment 52. Wood and Formad. Magnified 250.

"diphtheritic sore throat" is a strong evidence of this. There have been cases in which diphtheritic matters absorbed by a wound have produced symptoms very closely resembling those of ordinary septic blood-poisoning from post mortem wounds, &c.; there have beencases of the formation of false membrane about wounds, &c., without any known exposure to a specific diphtheritic poisoning, indicating that the systemic tendency to this peculiar form of exudation is capable of being engendered by other than the specific poison of diphtheria; finally, diphtheria seems sometimes to be produced by exposure to cold.

A general view of these facts seems to indicate that the contagious material of diphtheria is really of the nature of a septic poison which is also locally very irritant to the mucous membrane; so that when brought in contact with the mucous membrane of the mouth and nose it produces an intense inflammation without apsorbtion by a local action. Whilst absorption is not necessary for the production of the angina, it is very possible that the poison may act locally after absorption by being carried in the blood to the mucous membrane. Further, under this theory it is possible that the poison of diphtheria may cause an angina which shall remain a purely local disorder, no absorption occurring, or a simply local trachitis produced by exposure to cold, or some other non-specific cause, may produce the septic material when absorption shall cause blood-poisoning, the case ending as one of adynamic diphtheria.

Some such explanation as those here offered seems to reconcile the antagonistic opinions concerning the value of local treatment in diphtheria; because it is plain that the value of such treatment must largely depend upon whether the angina has or has not been preceded by absorption.

There is one more important clinical feature of the disorder, which under other views of the disease seems inexplicable, but which with the present theory is easily explained. Diphtheria differs from the exanthemata by the fact that one attack in no way protects against a second. It will be seen that the theories here put forward remove the affection entirely from any relation with exanthemata, placing it rather with septic diseases, which, as is well known, may recur indefinitely.

We want, however, distinctly to state that we do not consider these ideas to be more than suggestions, and it is useless to speculate, except as a guide to further experimental research. It does seem to us that there are now two pathways clearly open, which, if carefully followed, must lead to important positive or negative results. The first of these consists in the making of careful culture experiments to determine whether there is or is not any difference between the bacteria of ammonia and diphtheritic false membranes; the second, the study of the induction of epidemics of pseudo-membranous angina and trachitis in the lower animals, and the relation to these of the rapid cases of death produced in the lower animals by diphtheritic inoculation.

There is still another somewhat different view, which seems also not repugnant to the known facts of the case. There may be bacteria, which, although they offer no points of difference detectable by our best microsocopes, are really very diverse. Two spermatozoa or two ova in the higher animals may seem to be exactly alike and yet be potentially widely separated. Although, therefore, the bacteria of an ammonia false membrane seem identical with those of a diphtheritic false membrane, they are not of necessity really so. Careful studies of the blood of patients who die of diphtheria should be made, but at present it seems altogether improbable that bacteria have any direct function in diphtheria, *i. e.*, that they enter the system as bacteria and develop as such in the system and cause the symptoms. It is, however, possible that they may act upon the exudations of the trachea as the yeast plant acts upon sugar, and cause the production of a septic poison which differs from that of ordinary putrefaction, and bears such relations to the system as to, when absorbed, cause the systemic symptoms of diphtheria. Now, these bacteria may be always in the air, but not in sufficient quantities to cause trachitis, but enough when lodged in the membrane to set up the peculiar fermentation; whilst, during an epidemic, they may be sufficiently numerous to incite an inflammation in a previously healthy throat.

UNIVERSITY OF PENNSYLVANIA, *July* 1, 1880.

APPENDIX H.

REPORT OF MICROSCOPICAL EXAMINATION OF SUSPENDED PARTICLES FOUND IN THE ATMOSPHERE.

BY GEORGE M. STERNBERG, *Surgeon, U. S. A., Secretary of Havana Yellow Fever Commission.*

INTRODUCTION.

The following brief report contains a summary of the results obtained by the writer up to the present time (January, 1881) in his studies of "dust," or the suspended particles found in the atmosphere.

These studies were commenced in Havana, and have since been continued in Washington City and in New Orleans, in compliance with instructions contained in a communication from the secretary of the National Board of Health dated December 27, 1879.

A considerable portion of my time has been devoted to these researches, both in Havana (as a member of the Yellow Fever Commission) and in New Orleans, but I have not considered the results of sufficient value to justify me in placing upon record a detailed account of all the observations made.

The most important result is, in my opinion, the conclusion which I have reached, and which agrees with the observations of Cunningham, Miguel, and other observers, that bacterial organisms are not found in the atmosphere, even in crowded cities in a southern latitude and during the summer months, in any considerable number, in a recognizable form, and consequently that the method by direct examination, which I have chiefly employed, does not give promise of definite results in regard to the supposed relation of these minute organisms to the prevalence of epidemics.

As, however, the presence of germs not recognized by direct examination, is demonstrated by the abundant development of bacterial organisms in sterilized organic liquids exposed to the atmosphere, it is hoped that the method by culture experiments, in which a variety of organic liquids, exposed in different localities, at different seasons, and during the presence and absence of epidemics, may give better results.

The careful study of organisms developed in such liquids, the isolation and cultivation of special forms with a view to testing their physiological action upon animals, and experiments relating to the production of pathogenic varieties of common and usually harmless bacteria, present a broad field for experimental investigation which, I believe, will not prove so barren of important results as have the methods heretofore chiefly relied upon.

REPORT.

Ehrenberg first studied dust in 1830, and in 1848 devoted himself to a search for the cholera germ. Since this time numerous attempts have been made to throw light upon the etiology of epidemic diseases by the study of infected atmospheres. The generally accepted view as to the particulate nature of disease poisons, the indisputable evidence of their presence in the atmosphere during the prevalence of pestilential diseases, and the increasing interest in microscopical studies which has been developed *pari passu* with the perfecting of the microscope, have induced many persons to devote more or less time to these investigations. Prominent among these investigators are the names of Ehrenberg, Robin, Gaultier de Claubry, Pouchet, Pasteur, Joly, and Musset, and Miguel, of France; and Swayne, Britton and Budd, Thompson, Samuelson, Parkes, Hewlett, Maddox, Cunningham, Angus Smith, Sanderson, Dancer, and Tyndall, of England.

It must be admitted that so far as the main object of these studies is concerned, no definite results have been achieved. The subtle germs of disease have either eluded observation because of their minute size, or have escaped recognition among the multitude of particles of various kinds which make up the "dust" found everywhere suspended in the atmosphere.

It is evident that an acquaintance with the harmless organisms found in the atmosphere during the absence as well as during the prevalence of epidemics is a necessary prerequisite to the intelligent study of an infected atmosphere. To one unfamiliar

with these organisms the spore of a common cryptogam or a pollen grain is a possible disease germ. It is, therefore, necessary that the investigator possess some knowledge of these more conspicuous objects before attempting to study the minute granules, barely visible with the highest powers, among which, if at all, the objects of our research are most likely to be found. My experience in Havana, the results of which will be detailed hereafter, convinced me of the importance of such preliminary studies and has induced me to supplement my first efforts, necessarily unsatisfactory from my own experience, and the brief time allotted to the Havana investigation, by subsequent experimental researches in New Orleans, and by a review of the literature relating to this subject. It is my intention to give in this report a general account of the results obtained by myself and by other observers in various parts of the world, in the microscopical analysis of the suspended particles in the atmosphere, known vulgarly as "dust."

The grosser materials which make up the bulk of the dust always present, in greater or less amount, in the lower strata of the atmosphere, are readily obtained from surfaces upon which deposition has taken place, from articles of furniture, window-ledges, &c., in dwellings and hospitals; from roofs of houses, the surface of leaves, fruits, &c. An excellent method is to expose glass slides in sheltered locations for a day or two; the dust which is deposited adheres to the surface with considerable tenacity and is conveniently distributed for microscopical examination.

This method, however, gives an excess of the earthy particles and the grosser kinds of organic *débris*, which possess but little value for the microscopist, who is chiefly interested in the study of the organisms present in the atmosphere, which, although sometimes deposited with this grosser material,* are obtained in greater number, and in better condition for examination by other methods.

The method which has given the best results, and which I have used in my own studies, consists in the projection of a current of air passing through a small aperture against a glass slide having a little glycerine or other viscid liquid smeared upon its surface. It matters not whether the air be projected against the glycerined slide by the natural force of the wind, as in the apparatus of Maddox used by Cunningham and Miguel (see Fig. 3, Plate I), or by a propelling force, as in the apparatus of Klebs and Tommasi Crudeli, Fig. 2, Plate I, or by aspiration, as in the apparatus which I have employed, Fig. 1, Plate I. The latter method, however, admits of the introduction of my metal case (Fig. 4, Plate I), which is used in connection with a water aspirator, into sewers, holds of ships, &c., where the aeroscope of Maddox would not be available.

Other methods are, that employed by Pasteur, in which air is filtered by passing through cotton, from which the particles are subsequently washed, or through gun cotton, which may be dissolved in ether, and the method by precipitation of atmospheric moisture upon artificially refrigerated surfaces.

The nature and quantity of the particles collected by any of the forms of apparatus referred to will vary in accordance with circumstances relating to location, elevation, season, meteorological conditions, &c.

In dwellings, hospitals, &c., a considerable portion of the dust collected consists of fibers of wool, linen, and cotton detached from clothing, bedding, carpets, &c., and of epithelial cells from the surface of the human body, mingled with more or less amorphous inorganic material and animal and vegetable *débris* of various kinds.

In the open air particles of mineral origin are more abundant. The nature and quantity of these depend, of course, upon the character of the soil in the vicinity, the force of the wind, &c.

Crystals.—I have met with several forms of crystals in my examinations of dust deposited upon the surface of glass slides exposed in various locations. The most common form is that shown in Fig. 4, Plate II. These crystals I have found quite frequently upon glass slides exposed in hospitals, in my laboratory, on ships, &c., both in Havana and in northern localities. They seem to be identical with crystals figured by Miguel as found in the atmosphere of Paris, and there is no good reason to suppose that they bear any relation to the prevalence of epidemic diseases. I have also found quite frequently associated with these minute navicular-shaped crystals, having sometimes one and sometimes both extremities acute. Again, I have occasionally found upon slides ,exposed in the vicinity of salt-water, cubical crystals of sodium chloride. Of greater interest are the crystals shown in Fig. 5, Plate II, which, so far as I know, have not been described by any previous observer, and of which I give the following account in the preliminary Report of the Havana Commission:

"Attention was particularly attracted to certain slender glistening acicular crystals radiating from little opaque masses, which were especially abundant in the yellow-fever wards and in the soiled-linen room of the military hospital. Subsequent observations in the United States have added to the interest which these striking objects

* The experiments of Professor Tyndall, in which he uses a beam of light as the most delicate test of the presence of floating particles in the atmosphere, prove that in a closed chamber where the atmosphere is undisturbed a complete deposition of all suspended particles occurs after a time.

aroused when first seen. Soon after the return of the Commission the National Board of Health had a session in Washington, and several of the members on returning to their homes took with them some watch-glasses arranged in little boxes, so that they could be conveniently packed and sent by mail. These watch-glasses were exposed in various places, and returned to Washington for microscopic examination of the dust deposited upon them. They were received in good order, and had adhering to the concave surface of each glass a deposit of dust more or less abundant, according to the place of exposure. Seven boxes, each containing two glasses, were received from infected localities, viz, two from Morgan City, La., four from Centreville, La., and one from Bayou Bœuf.

"Of these, six pairs of glasses had been exposed in the rooms occupied by yellow-fever patients, and one pair outdoors, in an infected locality. All of these glasses were found to have adhering to them a considerable number of radiating acicular crystals, exactly similar in appearance to those discovered in Havana. Eight boxes were also received from places supposed to be not infected, viz, four from Bellevue Hospital, New York, and four from Charity Hospital, New Orleans. The watch-glasses inclosed in these boxes had been exposed in the wards of these hospitals and in the dead-house and soiled-linen room of Charity Hospital. All were well covered with a deposit of dust, and none of those from New York presented any appearance of crystals. The glasses from New Orleans, however, had a very few of the acicular crystals described."

Samples of dust collected in the same way were subsequently obtained from hospitals in Boston, Philadelphia, and Mobile, and from the Soldiers' Home, Washington, D. C. None of these specimens contained the crystals described except those from Mobile. As there had been no yellow fever in this city during the year, the finding of the crystals here makes it extremely improbable that they bear any direct relation to this disease. But having been found only in southern localities, Havana, Morgan City, New Orleans, Mobile, Memphis, and during the season when yellow fever is likely to extend when introduced, the possibility remained that they might indirectly bear some relation to the epidemic extension of this disease. I have therefore made, during the present summer, additional researches by the same method. I have exposed slides on several occasions in the linen-room and wards of Charity Hospital, New Orleans, in my laboratory in the same city, and in the vaults of Lafayette Cemetery, but have not in any instance found the crystals which were so common on the surface of slides similarly exposed during the preceding summer. To test the question as to whether similar crystals would be formed in an atmosphere loaded with the volatile products of putrefaction, I exposed slides for many days under a bell-jar with putrefying meat-juice, but with negative results. Again, I exposed slides for forty-eight hours, in midsummer, in the vicinity of the "mill-pond," Salem, Mass. This locality is noted for its foul odors and insanitary surroundings, but it did not furnish any specimens of the crystals for which I was looking. My investigations, then, in relation to these crystals, have not led to any definite results in the way of determining their nature or significance. Soon after my return from Havana, my friend, Surgeon J. J. Woodward, called my attention to the fact that slides which have been kept in a cabinet for a long time often have upon their surface a considerable number of crystals, some of which exactly resemble the acicular crystals found by me in Havana, and similar crystals have been found "upon glass slips exposed in the air of various apartments in Washington during the months of June and July, 1880." (Report on Yellow Fever in the U. S. S. Plymouth in 1878-'79; Navy Department, Bureau of Med. and Surg., 1880.)

INORGANIC MATERIAL AND ANIMAL AND VEGETABLE DÉBRIS OF VARIOUS KINDS.

Out of doors particles of mineral origin are most abundant. The nature and quantity of these depend, of course, upon the character of the soil in the vicinity, the force of the wind, &c.

Vegetable debris.—In Havana and in New Orleans I have always found in my aspiration experiments a considerable quantity of vegetable *débris*, consisting of epidemic pellicles, fragments of cellular tissue, hairs of plants, and broken-down structureless masses. A mass of this kind, inclosing starch grains—probably banana—is shown in Fig. 1, Plate II. As these floating fragments are doubtless, in great part, derived from vegetables thrown into the streets, from garbage piles in out-of-the-way places, from the droppings of animals, and from decomposing algæ and plants of various kinds upon the margins of the gutters and canals in New Orleans, we have every reason to suppose that the respiration of an atmosphere loaded with such particles must have an unfavorable influence upon the health of those who are compelled to respire it. Although direct proof of this may be wanting, the prevalence of diarrhœal diseases, and the general lowering vitality among those who reside in localities especially subject to this kind of atmospheric contamination, makes it seem not improbable that this is an important factor in the production of disease. During the summer months, when putrefactive processes are active in the decomposing masses from which many

of these microscopic fragments are detached, we have a direct transfer from the gutters and garbage piles to the numerous surfaces of the respiratory passages of man, not only of these particles of vegetable tissue, undergoing retrograde changes, but of the minute organisms attached to their surface, which are the direct agents of these putrefactive processes.

The glycerined slide, in the form of aspirator, which experience proves is most successfully employed in arresting the particles suspended in the atmosphere, must be very much inferior to the extended mucous surface over which the inspired air gently plows before reaching the lungs of man, and we have every reason to believe that the expired air is returned to the atmosphere, free from the freight it carried upon entering the mouth or nares. This furnishes doubtless a necessary protection to the delicate tissues of the lungs, but it especially exposes us to whatever danger there may be from the retention of poisonous particles suspended in the atmosphere. The quantity of soot or dust which may thus be deposited upon the mucous membrane of the nares during a short railroad journey has doubtless attracted general attention, but the amount of more deleterious but less conspicuous material which may be thus deposited is a matter which, perhaps, has not received sufficient consideration.

It is evident that poisonous particles deposited in this way, if not absorbed directly from the mucous membrane, will find their way to the stomach with the saliva swallowed, while living germs will find in the human mouth and alimentary canal a warm and moist culture-apparatus, admirably adapted to the growth and multiplication of many species, as is proved by their constant presence there. (See Fig. 2.)

Animal debris.—The most common particles of animal origin are epithelial cells of man and animals—hair, fur, wool, fragments of feathers, the bodies of minute insects and broken fragments of larger ones, scales from the body and wings of lepidopterous insects, and from the mosquito (see Fig. 9, Plate II), &c.

Infusorial animals are not found in the atmosphere in a recognizable form, probably because their soft bodies are quickly dessicated and broken up when removed from a liquid medium. The eggs, or germs, of certain species are, however, sufficiently common, as is proved by the development of adult forms in pure water exposed to the air. I have found an abundance of *Monas lens* in distilled water kept in my laboratory, and the observations of Sanderson, Cunningham, Miguel, and others are to the same effect. The last-named author has given special attention to this subject, and estimates that there is an average of one or two infusorial eggs in ten cubic meters of air. As the result of carefully conducted experiments, in which rain-water was caught and inclosed in vessels purified by heat, Miguel makes the following statement:

"From these precise experiments it results that the eggs of the monads, of cercomonads, and of the rhizopods, are those which are the most widely distributed in the atmosphere."

Vegetable organisms.—The spores of cryptogams and pollen grains are the most conspicuous and most abundant vegetable organisms found in the atmosphere of New Orleans, as elsewhere. I have made many photomicrographs of the more common forms, but am only able to introduce a limited number of these in illustration of the present report, as the heliotype reproduction of my negatives would be attended with considerable expense, owing to the fact that usually but one or two spores are found in a single field, and consequently in each negative. I have therefore borrowed from the amply illustrated and admirable report of Cunningham (Microscopic Examinations of Air by D. Douglass Cunningham, Surg. H. M. Indian Med. Service: Report of Sanitary Commission with the Government of India, 1872), some figures (Fig. 5, Plate I) which illustrate at the same time the general appearance of the organisms found by him in the atmosphere of Calcutta, and by myself in New Orleans. While some of the figures drawn by Cunningham doubtless represent the spores of cryptogams peculiar to low latitudes in the eastern hemisphere, many of them do not differ from forms found by me in New Orleans, and belong to widely diffused species, *e. g.*, *Penicillium glaucum*, the spores of which are represented in my Fig. 8, Plate II, and the spores of a species of Botrytis (?) represented in Fig. 2, Plate II.

I judge from Cunningham's report and figures that certain cryptogamous plants, and especially the coniomycetous fungi, are more abundant in the vicinity of Calcutta than at New Orleans, where I have found the spores of *Penicillium* and minute hyphomycetes in relatively greater numbers than is indicated in this author's drawings. These differences, of course, depend upon season, climate, and local surroundings. Thus, in a vicinity where the grasses and cereals are extensively cultivated the fungi parasitic upon these plants would be most numerous, while in a locality surrounded by forests or swamps other species would abound. Miguel (*Etude sur les poussiéres organisées des l'atmosphère*, Annales d'Hyg. Pub. 1879, pp. 226–255, and 333–362), whose investigations, made at the observatory of Montsori, Paris, are the most recent and the most thorough of any with which I am acquainted, gives the following account of the spores of cryptogams found in his researches:

"The most abundant microbes are, without doubt, the spores of molds, the white and glaucous spores of *Penicillium*, the brown and greenish spores of *Aspergillus*, of *Core-*

mium, and of some species of *Botrytideæ*. The family of the *Torulaceæ* is also very largely represented among the productions held in suspension in the atmosphere. It would be difficult for us to indicate with exactitude the genera and species of these cryptogams which live and fructify in water and in nutritive liquids. Let us mention next the presence of numerous spores of the genera *Septonema*, *Alternaria*, *Dactylium* which we have been able to cultivate upon wood and upon cotton saturated with water. Let us indicate, in passing, the septate spores of *Leptotrichum*, of *Trichothecium*, of *Septosporium*, the spiral spores of the genus *Helicotrichum*, so abundant in the air after a rainy season, and those of the genus *Ceratocladium*, of which the form is comparable to an ergot of rye. The air of Paris is also loaded at all seasons with a crowd of *Fusidium*, of *Sclenosporium*, of which some in growing emit myalial threads from their pointed extremities, while many smooth, eliptical spores have as many as three or four myalial sprouts placed at different points of their circumference. Let us mention next the fructifications of the *Gonatobotrys*, of the *Arthrobotrys*, and the spores of a crowd of mucors, and of the caspore fungi. It is probable that certain fructifications, which it has been impossible for us to cultivate, belong to these voluminous fungi filled with several millions of spores. Let us mention, finally, some *Isaria*, which may be cultivated upon paper suitably moistened with ordinary boiled water, and we will have given but a very feeble idea of the innumerable variety of micro-germs suspended continually in the atmosphere. It is equally easy to discover in the dust carried by the winds numerous spores of lichens of mosses, and of all the cryptogams which give by dehiscence microscopic fructifications."

The considerable numbers and extensive distribution in the atmosphere of these spores of common cryptogams is, *a priori*, argument in favor of their harmless nature, and the researches which have thus far been made give support to this inference. Cunningham, after a painstaking investigation made in Calcutta, during the year 1872, sums up the results of his studies as follows:

"Spores and other vegetable cells are constantly present in atmospheric dust, and usually occur in considerable numbers; the majority of them are living and capable of growth and development; the amount of them present in the atmosphere seems to be independent of conditions of velocity and direction of wind, and their numbers are not diminished by moisture.

"No connection can be traced between the number of bacteria, *spores*, &c., present in the air and the occurrence of diarrhœa, dysentery, cholera, ague, or dengue, nor between the presence or abundance of any special form or forms of cells and the prevalence of any of these diseases."

So far as the diseases referred to are concerned, and as regards the more conspicuous spores of cryptogams commonly found in the atmosphere, the conclusions of Cunningham are probably correct. There is, however, some evidence that the spores of certain fungi may produce specific deleterious effects upon the human economy when inspired or injected into the circulation, and that the spores of certain common species, ordinarily harmless, may acquire, under exceptional conditions, hurtful properties. The anæsthetic properties of the "smoke" of the common puff-ball (*Lycoperdon proteus*) are well established. Mr. B. W. Richardson has found it possible to produce complete anæsthesia in animals—dogs, cats, and rabbits—by causing them to respire the fumes of this fungus. (Medical Times, Lond. N. S., vol. vi, 1853, p. 610.)

The cases and experiments reported by Saulsbury (Am. J. M. Sc., vol. xliv, 1862, p. 19) seem to prove that headache, catarrhal symptoms, and in some cases an eruption resembling that of measles, may be produced by respiring the emanations from moldy straw.

Somewhat similar effects have been observed in France to result from handling moldy seeds. (Jour. de Méd. Pratique de Montpellier, vol. i, p. 352.)

The doctrine of the polymorphism of these low forms, which numbers among its adherents many able naturalists (de Bary and others), opens a wide field for speculation and for experimental inquiry. But still more pregnant with important possibilities are the facts reported by Grawitz, which seem to show that the well-known fungi, *Aspergillus* and *Penicillium*, may undergo certain modifications as the result of a special method of cultivation, which change entirely their physiological action when introduced into the human body, without, however, producing any morphological changes in the fungus. Recent experiments seem to show that among the bacteria, which I am not at present considering, as I believe them to be more properly classed with the algæ, this change in physiological properties, as the result of cultivation in special media, is a not unusual occurrence; and there is a growing tendency, based upon experimental evidence, to explain the supposed noxious effects of the microphites found in the blood of certain diseases, especially of anthrax, upon the hypothesis of a change of this kind occurring in common forms rather than by the more widely accepted theory of independent and distinct species, morphologically not distinguishable the one from the other. The conclusions of Grawitz, whose experiments are above referred to, are as follows:

"1. The mold fungi, the best known of all and universally destributed, the *Eurotium*

(Aspergillus) and *Penicillium*, appear in two varieties, morphologically entirely alike, physiologically very different. One variety behaves with complete indifference in the circulation of the higher animals; the other must be assigned, as to malignancy, to the most virulent group of pathogenetic fungi known up to the present time.

"2. It is proved by experiment that both varieties can originate from any selected primary form by continued breeding, and likewise that each variety can be obtained from the other by systematic culture after about twelve to twenty generations.

"3d. The principle of breeding depends upon gradually accustoming fungi living in firm, weakly acid soil at a temperature of about 8° to 20° C., through a series of generations, to alkaline albuminous solutions having a temperature of 38° to 40° C.

"4th. The malignancy of the pathogenetic mold-fungi consists, in acute cases, in the fact that their spores, so soon as they arrive in the circulation of the higher mammalia, germinate there, pass into the different tissues of the body. develop among them, and produce local necrosis, which causes the death of the animal in about three days." (Virchow's Archiv. Bd. 81, p. 355.)

The Saccharomycetes, Nägeli, are widely disseminated in the atmosphere, as is proved by culture experiments with saccharine liquids which, when exposed to the air, soon give evidence of the presence of those budding cells, upon microscopical examination, and by the production of the alcoholic fermentation due to their presence. They are found, especially, in considerable numbers, attached to the surface of fruits (Pasteur).

Pollen.—The quantity of pollen carried by the winds is often very considerable, and from the varied and sometimes characteristic forms of these cells a microscopical examination may often determine the order or even the genus of plants from which they are derived, thus tracing them in some instances to distant localities. In the atmosphere of New Orleans, during the spring months, the pollen of the pine, Fig. 7, Plate II, is sometimes so abundant that after a rain it forms a yellow deposit upon the margins of the gutters. My friend, Dr. Devron, of this city, informs me that it is a popular superstition that this yellow deposit portends the occurrence of an epidemic of yellow fever later in the season.

I introduce Fig. 1, Plate II, which is from the pollen of *Carolinia*, a tree from Guiana, not as a specimen of pollen found in the atmosphere of New Orleans, but as a good example of the capabilities of photomicography in the representation of objects of this kind.

Pollen is, of course, more abundant in the spring of the year, and, as with the spores of cryptogams, the quantity and variety vary according to latitude and local surroundings. Miguel says:

"In order to give an idea of the abundance of these articles, we will say that in April, May, and June they are to the larger spores of the cryptogams as 1 is to 20, and that it is not rare to count several thousands of them in a single gathering."

Beyond the effect attributed to the pollen of certain grasses in the production of the disease known as hay asthma or summer catarrh, I know of no evidence going to show that the pollen suspended in the atmosphere plays a *rôle* in the production of disease.

Starch granules.—The considerable number of starch granules which, in common with other observers, I have found everywhere present in the atmosphere, was at first a matter of surprise to me. In my aspiration experiments, whether made in my laboratory in Havana or in New Orleans, in hospital wards, or in the streets, market places, and cemeteries of the cities mentioned, I have rarely failed to find a certain number of starch granules in every sample of dust obtained by the passage of ten gallons of air through my aspirator. When we consider the abundant presence of starch granules in the stems and leaves of certain plants, as well as in fruits and vegetables, and the fact that they are set at liberty, but not destroyed, by the putrefactive changes under which the cellular tissue breaks down, their abundant presence in the atmosphere is no longer surprising, In numerous culture experiments conducted in my laboratory in New Orleans, in which the pulp of various fruits and vegetables was kept under observation for two or three months for the purpose of studying the bacteria and fungi developed from air-borne spores, I have invariably found that the starch grains remained unchanged long after the cellular tissue which surrounds and incloses them has yielded to putrefactive processes.

"Starch grains seem to compose about the one-hundredth part of the organized productions carried by the winds."

Algæ.—Doubtless many of the amorphous particles of vegetable tissue found in the atmosphere are the desiccated fragments of confervoid algæ, but I have not found recognizable portions of the *confervæ*, or specimens of the *Desmideæ*, or of the *Diatomaceæ* in my researches.

This experience agrees with that of Miguel, who, however, has frequently met with the cells of Clorococcum, Protococcus, and Palmella. These genera are also represented by occasional cells in the air of New Orleans.

BACTERIA (*Schizomycetes, Nägeli*). Especial interest attaches to the question of the presence in the atmosphere of the minute algæ known under the general name of bac-

teria, because of the *rôle* of these organisms in putrefactive processes, and the accumulating evidence in favor of the "germ theory" of disease.

My observations accord with those of Cunningham, who says:

"Distinct bacteria can hardly ever be detected among the constituents of atmospheric dust, but fine molecules of uncertain nature are always present in abundance.

"Distinct bacteria are frequently to be found amongst the particles deposited from the moist air of sewers, though almost entirely absent as constituents of common atmospheric dust."

While this is true as regards the rods, torula chains, and spiral filaments so constantly met with in microscopical examinations of liquids, yet there is indisputable evidence that the germs from which these various forms of bacteria are developed are constantly present and widely distributed in the atmosphere. Many of these germs are of sufficient size to be seen with high powers, but to differentiate them with certainty from the inorganic granules and organic *débris* with which they are associated must be a matter of great difficulty. Their presence is, however, easily demonstrated by culture experiments in which sterilized organic liquids are inoculated by exposure to the air, or by adding to them small quantities of dust collected by aspiration or otherwise. Miguel says:

"The *bacillaire algæ*, which some authors place in the animal kingdom, but which we call *vibrionicus*, are always found in the air in the state of germs, visible by the aid of high powers when one takes the precaution to color them yellow with iodine."

In a subsequent paper (*Comptes rendus*, Acad. d. sci. xci, 1880, p. 64) Miguel claims to have succeeded in counting the spores of bacteria, and asserts that while always present in the atmosphere their number is subject to constant variations.

"Very small in winter, the number increases in spring, is very high in summer and autumn, then sinks rapidly when frost sets in. This law also applies to spores of fungi; but while the spores of molds are abundant in wet periods, the number of aerial bacteria then becomes very small, and it only rises again in drought, when the spores of molds become rare. Thus, to the *maxima* of molds correspond the *minima* of bacteria, and reciprocally.

"In summer and autumn, at Paris, 1,000 germs of bacteria are frequently found in a cubic meter of air. In winter the number not uncommonly descends to four or five, and on some days the dust from 200 liters of air proves incapable of causing infection of the most alterable liquids. In the interior of houses, in the absence of mechanical movements raising dust from the surface of objects, the air is fertilizing only in a volume of 30 to 50 liters. In Miguel's laboratory, the dust of five liters usually serves to effect the alteration of neutral bouillon. In the Paris sewers, infection of the same liquor is produced by particles in one liter of air.

"Miguel compared the number of deaths from contagious and epidemic diseases in Paris with the number of bacteria in the air during the period from December, 1879, to June, 1880, and established that *each recrudescence of aerial bacteria was followed at about eight days' interval by an increase of the deaths in question.* Unwilling to say positively that this is more than a mere coincidence, he projects further observations regarding it" (quoted from jour. of the Roy. Mic. Soc., vol. iii, No. 5, (October, 1880, p. 838).

While I have no reason to doubt that the more extended experience and superior technical skill of Miguel may have enabled him to give a certain value to these enumerations of the bacterial germs present in the atmosphere of Paris, I must confess that I have not felt sufficient confidence in my own power to differentiate with certainty veritable germs from pseudo germs of organic or inorganic origin, to induce me to make a similar attempt in New Orleans. For me, the capacity to grow is the only certain test of a living germ, and it is by testing this capacity in different media, and at different temperatures, and in carefully studying the life-histories of the organisms which develop from air-borne germs in different localities, at different seasons, and under varied conditions as to prevalence of disease, that I anticipate the most important contributions to our knowledge of the etiology of epidemic diseases.

Culture experiments.—I have made during the past two summers, both in Havana and in New Orleans, a variety of culture experiments designed to promote the development of the adult forms of organism represented by living germs suspended in the atmosphere. For this purpose I have used Cohn's fluid, urine, blood, animal and vegetable infusions, the pulp of various fruits and vegetables, &c. I have found a very suitable culture-fluid, especially for the saccharomycetes, to be the liquor from the interior of an unripe cocoanut. This liquor is preserved in a germ-proof receptacle—the shell—and, with proper precautions, may be drawn into a purified flask, without danger of contamination. Fish-gelatine solution, prepared in accordance with the directions of Klebs and Tommasi, seems to be a very suitable medicum for the cultivation of the schizomycetes, and in New Orleans I used it extensively and quite successfully, so far as the development of a variety of forms is concerned. My experiments have demonstrated the presence in the atmosphere of New Orleans, as elsewhere, of an abundance of germs of the common bacteria of putrefaction, but they do not seem worthy of being recorded in detail, as no new facts of value have been brought

to light. These bacteria are found to differ in different media, and also in the same medium, according to the time which has elapsed since the liquid was fertilized. These differences in form, in movement, in development, &c., have led to the establishment of numerous species, and much confusion exists, owing to the difference of opinion among naturalists as to the proper basis of classification, and the value of the species which have been described. It is generally admitted that in the present state of science it is impossible to make a satisfactory classification of these minute organisms, of which the life-histories are in great part only imperfectly known to us. For purposes of identification the classification of Cohn is probably the best which has been offered (see The Bacteria, by Dr. Antoine Maguin, translated from the French by G. M. Sternberg, Surgeon U. S. A., 8vo., Little, Brown & Co., Boston, 1881). This classification being based upon morphological considerations alone, is confessedly artificial and provisional in character. Cohn is convinced, however, that the bacteria are divided into species as distinctly as the other plants and inferior organisms.

"This is not the opinion of Hallier, Hoffmann, Billroth, Robin, Nägeli, and others, who consider the various forms to represent not so many autonomous species, but phases of development of one or several species. According to Billroth, the bacteria belong to a single species of plants, the *Coccobacteria septica*, with the exception of the *Spirillum* and *Spirochæta*. Robin also admits the genetic relation of *Micrococcus*, *Vibrio*, *Bacterium*, and *Leptothrix*, but considers them the distinct and successive phases in the evolution of several species" (l. c. p. 62).

Nägeli says, "As much as I am convinced that the schizomycetes cannot be grouped in accordance with their action as ferments and their exterior forms, and that altogether too many species have been distinguished, so, on the other hand, it seems to me very improbable that all the schizomycetes constitute a single natural species." (l. c. p. 63).

My own observations have not been sufficiently extended to entitle my opinion to great weight, but, so far as they go, they have led me to conclusions similar to those of Nägeli; and while I adopt the classification of Cohn as being convenient for descriptive purposes and for identification of the forms referred to by various authors, I suspect that the specific and generic distinctions depended upon are, to a great extent, artificial, and that the lower we descend in the scale of life the less successful will be the efforts of the systematists to classify organisms, which in nature are not separated from each other by well-defined lines.

The most common forms found in my numerous culture experiments have been *B. termo* and *Bacillus subtilis* Cohn. The former first makes its appearance and after a time is supplanted by the latter as an active agent in the culture-fluid. A photographic record of the life history of the bacteria developed from atmospheric germs in different media and in different parts of the country during the absence and during the prevalence of epidemic diseases might prove of great value in the study of questions relating to etiology, but this is an extensive labor which I have not yet been able to undertake, having been engaged in other studies, to a certain extent preliminary to this, which have fully occupied my time.

But still more important, in the light of recent experimental researches, is the determination of the question as to whether pathogenetic varieties of common and harmless bacteria may not be produced by cultivation in special media and under special conditions as to temperature, &c. The strongest arguments against the hypothesis that bacteria may play an important role in the production of epidemics are, the absence of proof that any unusual form makes its appearance simultaneously with the development of an epidemic, and the fact that the common forms are constantly present in the alimentary canal of man, and have frequently been injected into the circulation of animals without producing any serious result. If, however, it can be shown that bacteria, usually harmless, may develop into pathogenetic varieties without undergoing any recognizable morphological change, these arguments will lose their force, and a broad field for experimental inquiry is revealed to us, in which we may yet find the answers to those questions of etiology which have thus far eluded all researches. The experiments of Grawitz upon Penicillium; the results obtained by Pasteur in producing a modified and protective form of chicken-cholera by cultivating in his laboratory the micrococcus, which is the active agent in producing the disease (C. R. Ac. des. Sci. XC, pp. 239, 952, and 1030); the intensification of the pathogenic properties of *Micrococcus septicus*, as the result of successive inoculations from one animal to another (experiments of Davaine and of Koch); and the recent experiments of Greenfield (Proc. Roy. Soc., Vol. III, No. 5, p. 838) and of Buchner, which seem to show that the common *Bacillus subtilis* may develop pathogenic properties as the result of special conditions of cultivation, and that *Bacillus anthracis* may lose its virulence after successive cultivation for a number of generations in aqueous humor, all point in the same direction, viz, to the extreme modifiability of the bacteria, so far as their physiological action is concerned, as the result of varying conditions relating to their environment.

A like modifiability, as regards morphological and developmental changes, is claimed

78

PLATE II.

Fig. 1.—This photomicrograph is from the pollen of *Carolinia*, a tree from Guiana. The specimen was brought to me by my friend, Dr. Gustav Devron, of New Orleans, and the photograph is introduced to illustrate the fact that pollen is one of the most common organisms found in the atmosphere, and more especially to show that satisfactory photographs may be made of organisms of this kind. The amplification is 200 diameters.

Fig. 2 is from the surface of a glass slide exposed in a vault in Lafayette Cemetery, New Orleans. These oval spores are believed to belong to a fungus of the genus *Botrytis*. Amplification, 400 diameters.

Fig. 3 is from an aspiration experiment made in front of my laboratory in New Orleans, and represents a mass of decomposing vegetable tissue containing starch granules. × 200 diameters.

Fig. 4.—From surface of glass slide exposed for forty-eight hours in military hospital, Havana, × 400. These crystals are found elsewhere, and their presence in the hospital is believed to have no special significance.

Fig. 5.—Crystals from surface of glass slide exposed for forty-eight hours in military hospital, Havana. × 212 diameters. (See remarks on page ——.)

Fig. 6.—Crystals from surface of watch-glass exposed in open air, Morgan City, La., 1879. × 300 diameters. (See remarks on page ——.)

Fig. 7.—Pollen of pine and spores of fungus, common in the atmosphere of New Orleans during the spring months. × 200 diameters.

Fig. 8.—Spores of *Penicillium glaucum*, common everywhere. × 400 diameters.

Fig. 9.—Scales from body of a mosquito, common in the atmosphere of New Orleans and elsewhere. × 200 diameters.

APPENDIX I.

PATHOLOGICAL HISTOLOGY OF YELLOW FEVER.

BY J. J. WOODWARD, *Surgeon U. S. A.*

The following remarks on the pathological histology of yellow fever were prepared at the request of the National Board of Health, and submitted by Dr. Woodward April 6, 1881.

ARMY MEDICAL MUSEUM, *April* 6, 1880.

Dr. JAMES L. CABELL,
President of the National Board of Health:

DEAR SIR: November 4, 1879, I had the honor to receive a letter from the secretary, requesting me, in the name of the National Board of Health, to examine a number of pathological specimens from subjects dead of yellow fever, collected by the commission sent to Havana during the previous summer. I was asked in case the specimens proved to be of such character and in such a state of preservation as to permit it, to "prepare a report on the pathology of yellow fever," to be published with the reports of the Havana commission, or, as an alternative, at least to "indicate the direction in which research is most needed and is most likely to prove of value." At a subsequent period I received from the secretary of the Board a number of permanently mounted microscopic slides prepared by Dr. J. Guiteras, one of the members of the commission, from specimens collected at the same time as those sent me.

I replied to the letter of November 4 that I was ready to comply with the wishes of the Board to the extent of my power; and accordingly, since that time, I have not only made a microscopical investigation of the pathological pieces sent me, so far as their condition permitted, and examined with care the mounted preparations of Dr. Guiteras, but have studied the most important recent contributions to the pathological anatomy of this disease, in order to acquaint myself as fully as possible with the present state of knowledge on the question at issue.

I regret to say that the pathological pieces sent me were not in a condition for very satisfactory study, the autopsies having been performed too long after death (5 to 18 hours). We have the testimony of a number of trustworthy observers that cadaveric changes occur much more rapidly after death from yellow fever than after death from ordinary non-malignant acute diseases, so that the period mentioned, which in the tropical climate of Havana during July and August would be, I should suppose, quite sufficient to impair the value for refined histological researches of the normal tissues of those dead by violence, might be expected to give rise to still more serious changes in those dead of yellow fever. To this cause also, in part, I attribute the circumstance

17

I undertake this work with great modesty, since the disease is one I have never seen, but I have endeavored to make myself acquainted with the best recent observations, and bring to their consideration such general knowledge of pathological histology as I have acquired by studies which now extend over more than a quarter of a century. I hope therefore that the suggestions I am about to present may not be without value to those who may hereafter undertake to investigate the histological lesions of yellow fever.

These suggestions can be most advantageously presented in connection with a brief statement of the principal differences between the accounts of recent observers; for evidently our first step forward must be to endeavor to ascertain by observation which of these discrepant statements is in accordance with facts, or, if in any case none of them fully represent the facts, to ascertain what these actually are. I shall make no attempt at a complete analysis of the very voluminous recent literature, but only refer to what appear to be the most significant original observations.

The histologist who may undertake to study the lesions of yellow fever, will find it necessary to the interpretation of the conditions observed in the dead body to make certain investigations during the progress of the disease at the bedside of the sick.

A.—MICROSCOPICAL INVESTIGATIONS AT THE BEDSIDE OF THE SICK.

These refer especially to the blood, the black vomit, and the urine.

1. *The blood.*—And, first, as to the examination of the blood, which has been regarded by so many physicians as the primary seat of the specific changes produced by the yellow-fever poison, or at least as the vehicle by which the poison is conveyed to the nervous centers or other parts supposed to be the first seat of morbid action. The most important discrepancies between the modern accounts of the pathological histology of the blood in yellow fever refer to the condition of the red and white corpuscles, and to the alleged detection of low vegetable forms, supposed to be related to the causation of the disease.

Can any change be detected with the microscope in the red corpuscles of yellow-fever blood? The old observation of Bienperthuy (1844), who affirmed that even at an early period of the disease "the parenchyma which serves as an envelope to the globules was destroyed," was long ago contradicted by that careful microscopist Prof. Joseph Leidy (1854),* who was unable to discover "the slightest indication of such a process," and reported that in the cases he examined with the microscope "the corpuscles were found apparently unchanged." Yet the opinion that in this disease the red-blood corpuscles in some way break up, and that perhaps the characteristic icterus is due to the "transformation of their hæmatine into bile pigment within the circulation," has continued to find adherents, as may be seen by the article of Haenisch, in Ziemssen's Cyclopædia. Two of our own countrymen, Dr. Joseph Jones and H. D. Schmidt, have recorded observations, made in New Orleans during the epidemic of 1878, which appear to lend some support to this opinion. Dr. Joseph Jones observed that in the blood drawn by cut cups from yellow fever patients, "the colored corpuscles presented a crenated appearance," due to "irregular elevations or exudations of the surface of the corpuscles," or "presented a stellate and granular appearance, as if minute globules were forming upon the surface of the cell membrane."†

Dr. H. D. Schmidt carried his microscope with him into the hospital ward, and took, it would appear, many precautions in order to observe the blood as fresh as possible. He examined the blood of fifteen cases, and in all, "with the exception of two, the colored blood corpuscles presented the crenated form." Dr. Schmidt regards this change as probably "retrogressive in character, indicating a loss of vitality on the part of the blood corpuscles," and, quite in harmony with this view, he recognizes the presence of "hæmoglobulin escaped from the blood" in the granular cells of "the liver and some other organs," and mentions that he observed "free hæmoglobulin" in one of the specimens of blood he examined, although he remarks that this "is a phenomenon sometimes even met with in the examination of normal human blood."

Dr. John Davy (1847) long since observed that when blood taken from the body of a subject dead of yellow fever was examined under the microscope "the corpuscles were seen to be corrugated, as if from incipient putrefaction;" but he did not recognize this condition in blood taken from living patients, nor has it attracted the attention, so far as I know, of any recent observers other than those cited above. Deputy Inspector-General Robert Lawson, writing in 1862 of the yellow fever of Jamaica, remarks: "It seems still a common belief that the blood in yellow fever is in a dis-

*See "La Roche," Vol. I, p. 171. To avoid repetitions, I shall not, as a rule, give references to the authorities cited in this paper, but will append a list of the several books and essays referred to.

†It is to be inferred that these examinations were always made in the manner described in connection with the observation here cited: "I hastened to my laboratory with the blood of the patient, which had been received into glass-stoppered bottles, chemically clean, and which had never been used before, and submitted the blood to microscopical examination." See the first essay of Dr. Jones, cited in the appended list, p. 952.

solved state. * * * The blood, however, is not dissolved, but the globules remain distinct and well formed." In like manner, Dr. J. Crevaux, a French naval surgeon, who has studied with evident care the pathological histology of yellow fever during the epidemic of 1877 in French Guiana, declares that he found no sensible alteration of the blood globules. Less definitely, Dr. M. A. Guichet, a French military surgeon, writes, from examination made during the Madrid epidemic of 1878, that he found the red-blood globules little altered or healthy; but these examinations appear to have been made after death.

During the summer of 1879, Surgeon George M. Sternberg, one of the members of the Havana commission referred to at the commencement of this paper, spread out thin and dried, on glass slides, in order to photograph them, ninety-eight specimens of blood taken from fifty-one cases of yellow fever (mostly soldiers in the military hospital of San Ambrosio), without, in his opinion, observing any greater tendency to crenation than is observed in normal blood—an opinion which, I may say, is sustained by the beautiful photographs taken by this gentleman.

I cannot, however, feel, after perusing the publications in which the foregoing discrepant statements are set forth, that any one of them is based upon such exhaustive and thorough researches as to warrant us in regarding it as final. On the one hand, it must be remembered that the crenation of the red-blood corpuscles is a phenomenon that habitually ensues upon the withdrawal of blood from the healthy human body. It occurs at a period which varies in accordance with variations in the method in which the specimen is treated, such as the violence with which it is handled, the degree of exposure to atmospheric air, &c., and which is probably also modified by variations in the specific gravity of the serum as much as by the vitality of the blood corpuscles. In the present state of our knowledge we must regard this process, in any case, as one of the first manifestations of departing vitality in the red-blood corpuscles, and therefore it seems reasonable enough to suppose that in yellow fever, perhaps also in all diseases in which observation shows that putrefaction occurs unusually soon after death, this change would occur at an earlier period after the withdrawal of the blood from the body than happens in normal blood; and particularly that this would be the case with blood drawn from malignant cases shortly before death. But reasonable enough as this appears, the evidence does not satisfy me that it actually happens, and further researches should, I think, be made by some one who has first found time to study in a more thorough manner than has yet been done the phenomena of the crenation of the colored corpuscles in healthy individuals and in other diseases.

As for the old speculation to which Haenisch has again given voice, that the fatty degenerations, hæmorrhages, and other lesions of this disease are due to a previous destruction of the red corpuscles occurring on such a scale as to cause the blood "to lose its capacity for nourishing the tissues of the body in the normal way," I have not been able to hear of any observer who has undertaken to test it by any of the recently devised ingenious plans for estimating the number of corpuscles in a measured quantity of definitely diluted blood by actual count;* and I would specify this as one of the investigations which should be undertaken, for surely if an actual breaking up of the red corpuscles of the blood has anything whatever to do with the pathology of this disease, it would be possible to establish the fact of their diminished number, in the latter stages of the disease at least, by an actual count.

Can any changes be observed with the microscope in the white corpuscles of the blood of those suffering with yellow fever? This question does not appear to have attracted attention until quite recently, and even among the latest observers several, like Dr. H. D. Schmidt, declare that nothing especially abnormal could be discovered by them in these elements. On the other hand, Dr. Joseph Jones describes the colorless as well as the colored corpuscles as presenting "a distinctly granular appearance, wholly unlike the conditions of these constituents in healthy blood;" and Surgeon G. M. Sternberg has observed in many of the white corpuscles of yellow-fever blood certain highly refractive granules, which he interprets as fat, and regards as representing a fatty degeneration of these cells. Surgeon Sternberg, it is true, as I myself have done, has found similar granules in the white-blood corpuscles of healthy individuals. But in this case the number of granules in each corpuscle was small, and the process was absent from the great majority of the globules, "while in severe cases of yellow fever the granules were abundant, and nearly every white corpuscle contained some of them." These statements are well supported by Surgeon Sternberg's photographs; so that the facts may be regarded as established for the cases observed, but further researches appear to be required to indicate the full significance of this observation.

Dr. J. Crevaux, who does not mention the conditions just described, testifies that he found in the blood of yellow-fever patients a greater number of fatty globules than

* For this purpose the hémetomètre of MM. Hayen and Nachet, the hæmacytometer of Graves, or the similar apparatus made by Zeis (of Jena) may be used; only in any case care should be taken to carry the count far enough to obtain a definite result. On this subject consult E. Abbe, Ueber Blutkörper-Zählung, Sitzungsberichten der Jenaischen Gesellschaft für Medicin und Naturwissenschaft. Sitzung vom 29 November, 1878.

occur in the physiological condition. Guichet makes a similar observation, and Dr. Joseph Jones has stated, on the basis of chemical analysis, that there is an increased percentage of fatty matters in the blood of this disease. Shall we conclude from this testimony a fatty degeneracy of the blood; and, if so, is it peculiar to yellow fever, or does it occur also in typhus and other malignant fevers? Besides the further investigation of these questions, inquiries are needed as to whether any changes can be observed in the structural details of the protoplasm of the white corpuscle in this disease; and also as to whether in the duration of their amœboid motion on the warm stage, or in other particulars, any noteworthy alteration in their vital manifestations can be observed.

Can the microscope discover in the blood of yellow fever any low vegetable forms, or other bodies which may be supposed to be related to the materies morbi? Dr. Joseph Jones and Dr. J. G. Richardson of Philadelphia, have made observations that appear to favor an affirmative answer to this question. Dr. Jones states that he observed in the freshly-drawn blood of a yellow-fever patient "minute oval bodies with a central nucleus," similar in size and appearance to those he found in water through which the air of "yellow-fever rooms" had been passed. He also states that he has seen "bacteria and delicate thread-like filaments" in the blood and urine of yellow-fever patients, and similar ones in "the water from yellow-fever rooms." At the Richmond meeting of the American Public Health Association, in November, 1878, Dr. Richardson is reported to have said that he found many dumb-bell-shaped bacteria (which he proposes to call *B. sanguinis*) in the blood of yellow-fever patients sent to him hermetically sealed. On the other hand, while the presence of such bodies is ignored by Crevaux, Guichet, and others who have recently examined yellow-fever blood with the microscope, Dr. H. D. Schmidt testifies that he was unable to discover "a single bacterium or spore of a fungus," although he "honestly endeavored to do so." Surgeon Sternberg likewise, in his examination of the blood of yellow-fever patients at Havana in 1879, entirely failed to discover low vegetable forms in any freshly-drawn specimen, although he states that in some (not all) of the samples he preserved for a time in culture cells "hypomycetus fungi, and spherical bacteria made their appearance after an interval of from one to seven days;" these he believes, for reasons which appear conclusive, to have originated from the accidental admixture of atmospheric germs. In this condition the question remains at the present time. Certainly there is room here for further careful observation, and although I confess that I am not sanguine that it will yield other than negative results, I think the subject ought not to be neglected in future work.

2. *The black vomit.*—That the black vomit owes its characteristic appearance to the admixture of blood was long ago established by the observations of numerous microscopists, who have also, as is well known, observed epithelial cells, oil globules, and divers *débris* of food. The chief interest at present connected with the study of this excretion centers in the question, *Can any low vegetable forms that may possibly be connected with the causation of yellow fever be discovered in the black vomit?* The question of the presence of low animal forms, raised by Rhees in 1820, had already been thoroughly disposed of when La Roche wrote, and needs no discussion in this place.

Already, at that time also, the question of the presence of characteristic low vegetable forms had been brought into notice, especially by the descriptions and figures of Hassall, but as the branching fungus described by this microscopist was found in a sample of black vomit examined some time after its evacuation, and as similar forms have not since been observed, no importance can be attached to it. Among recent observers, Dr. Joseph Jones states that he has found great numbers of bacteria, micrococci, and other low vegetable forms in black vomit examined immediately after its ejection.* Dr. H. D. Schmidt, on the other hand, declares that the vegetable form he most commonly found in the recent vomit was "the so-called yeast-plant, or torula cerevisiæ," though he adds that other fungi will develop if the specimen is left standing, "as these fungi get into the stomach with the food or the air swallowed." He remarks: "They have no relation to the cause of the disease. I still regret the time which I have spent in their cultivation, as I might have applied it to more practical examinations." A significant remark, and yet, I suppose, in the present condition of the vexed questions connected with the germ theory of disease, it is still desirable to press inquiries in this direction also; but such inquiries, to be fruitful, must be made by an observer who is well acquainted, on the one hand, with the botanical families to which any forms that may be discovered in the black vomit belong, and, on the other hand, with the forms that normally occur abundantly in many parts of the alimentary canal, and with the conditions that may lead to their appearance in the stomach also. Moreover, in all such inquiries, we must be careful to distinguish between what is found in the black vomit remaining in the stomach after death, and

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* "The black vomit was conveyed immediately to my laboratory and subjected to chemical and microscopical examination. * * * The whole mass literally swarmed with bacteria, micrococci, spirillum undula, vibro serpens, spirochæte plicatitis, spirochæte obermeii, spirillum tenue, micrococci, and delicate dichotoma threads, and the thallus of a delicate fungus, the diameter of which did not exceed one ten-thousandth of an inch." See p. 953 of the first paper of Dr. Jones, cited in the appended list.

first examined after the autopsy some hours later, and that which can be observed in the vomit ejected during the life of the patient and immediately examined. The importance of this discrimination is well illustrated by the statement of Surgeon Sternberg, that the black vomit ejected during life contains scarcely any cylindrical epithelial cells from the gastric mucous membrane, while that found in the stomach after death contains them in large numbers, an observation which corresponds perfectly with what is known of the occurrence of columnar cells from the intestinal epithelium in the rice-water discharges of cholera.

The urine.—Two questions of interest require further microscopical examination in connection with the urine in yellow fever. The first is raised by the statement of Dr. Joseph Jones, already mentioned, that he has observed "bacteria and delicate thread-like filaments" in the urine of yellow-fever patients, as well as in the blood and in the air of the sick-rooms. So far as I know, this statement is not supported by the observations of any other credible observer, but it is not on that account to be cast aside in the present state of our knowledge without further question. It seems desirable that this part of the general question of the imagined relation of yellow fever to vegetable germs pre-existing in the air should also be considered by competent observers in connection with similar inquiries with regard to the blood, the vomited matters, the tissues of the dead body, and, finally, the air itself. In connection with such examinations of the urine, however, the great rapidity with which micrococci, bacteria, and penicillium develop in this fluid in hot weather, and particularly the rapidity with which micrococci and bacteria develop under such circumstances in albuminous urine, should be steadily borne in mind.

The second question relates to the histological characters of the ephithelial cells and tube-casts found in the urine; the morphology of the latter being especially important in connection with the interpretation of the structural lesions of the kidneys found after death. Notwithstanding certain negative statements, the fact of the frequent occurrence of tube-casts in the urine during the albuminuria of yellow fever appears to be established by the testimony of several competent observers. We need, however, more definite details than we yet possess with regard to their characters and the circumstances of their appearance. The most detailed information on these heads, so far as I know, has been given by Lawson, who states that about the fourth day of the disease a copious deposit of pavement epithelium from the bladder makes its appearance in the urine. On the fifth day this is replaced by a copious deposit "composed of granular tube-casts from the kidneys," 1 to 1.3 thousandths of an inch in diameter, with sometimes an admixture of the "solid transparent casts called waxy." After the sixth day the casts found are more and more hyaline, and if the patient survives a few days longer they entirely disappear. Somewhat less detailed is the description of the casts observed in the urine of some yellow-fever patients at Louisville, Ky., during the fall of 1878, which has been published by Dr. J. W. Holland, of that city; but it has the advantage of being accompanied by a plate representing the appearances observed. The observations of Dr. Holland closely correspond with those of Lawson. On the third day in several cases, before the appearance of albumen in the urine, he found epithelial cells from the bladder, and "spindle-shaped cells, probably from pelvis of kidney." The same forms were also sparingly found at a later period in some mild cases in which albuminuria was at no time present. After the fourth day, in severe cases, the urine became albuminous, and tube-casts made their appearance; they were "highly, moderately, and slightly granular" and "some have epithelium embedded." The granular part of these casts is probably "made of the disorganized cellular lining" of the kidney-tubules, the clear portion of the "mucoid matter of Beale." Some of them are from the straight, others evidently from the convoluted portion of the tubules. In a single case only were unmistakable waxy casts found. These are, so far as I know, the only observers whose descriptions of the tube-casts are at all definite, or who have attempted to connect their appearances and characters with the stages of the disease in which they occur. It is evident that there is room in this direction for much further study, and especially that the relations in morphology and composition between the casts seen in the urine during life with those found in the kidneys after death should be made the subject of critical study.

B.—HISTOLOGICAL INVESTIGATIONS OF DISEASED TISSUES AND ORGANS.

Under this heading I shall discuss especially the lesions hitherto discovered in the nervous centers, the heart and blood-vessels, the stomach, the liver, and the kidneys.

1. *The nervous centers.*—The prominence of nervous symptoms in certain forms of yellow fever, as well as the speculative views of those who suppose the yellow-fever poison to act primarily upon some part of the nervous system, have led to many vain efforts to discover characteristic lesions in the cerebro-spinal axis, or the sympathetic ganglia.

Cerebro-spinal axis.—Already in the accounts of the older dissections we read of the

occasional occurrence of congestion and œdema of the brain and its membranes, and similar appearances have been noted in the spinal marrow and its membranes, particularly in their lower portion. Ecchymosed spots have also been observed on the surface of these as well as of other internal organs. But none of these appearances are constant, and it has become evident that histological research alone affords any promise of further information in this direction. Yet the histological investigations hitherto undertaken have contributed very little to our knowledge; nor is this surprising, for it is precisely in connection with the nervous centers that our notions of normal histology and of the minute changes occurring in other diseases is most imperfect, the soft and delicate tissues of these organs presenting special difficulties to the investigator. Lawson alone has recorded microscopical appearances which suggest the idea of a commencing meningitis in cases characterized by well-marked head symptoms. In such cases he states that he found "large exudation corpuscles" in the white matter "near the surface of the hemispheres," and that the nuclei in the walls of the minute blood-vessels were abnormally numerous. On the other hand, Gama Lobo, who made, during the Brazilian epidemic of 1873–'74, three autopsies, in which considerable cerebral congestion was observed, is reported by Rey to have found no other morbid process than fatty degeneration, involving especially the cerebral cells and the walls of the cerebral capillaries. Dr. H. D. Schmidt observed similar conditions at New Orleans during the epidemic of 1878. He relates that he found fatty degeneration of the "ganglionic bodies" of the cortex cerebri, and of the nuclei of the walls of the minute vessels ("venules as well as arterioles") of the pia mater, and of the cortex cerebri. In many vessels the nuclei had disappeared, leaving a number of fat globules in their places. At the same time, others were met with in which there was an increase of the protoplasm surrounding the nuclei in the normal condition, causing a thickening of the walls of the vessels, and giving rise "to minute aneurisms, and a final rupture of the vessel." Besides this he observed, in almost all the cases examined, an exudation of finely-granular matter in the subarachnoid space, and filling up the meshes of the pia mater.*

So far as I know, the foregoing are the only structural lesions believed to have been observed by microscopists in the cerebro-spinal axis of subjects dead of yellow fever. Knowing the difficulties that surround such investigations, I feel compelled to receive them with a certain reserve, although certainly the fatty degeneration described by Gama Lobo and Schmidt seems consistent enough with what we know of the other lesions in this disease. In further investigations the true nature of the appearances supposed to indicate the existence of fatty degeneration in the parts under consideration should certainly be tested on perfectly fresh specimens by the action of suitable reagents, such as osmic acid especially, and after the appearances observable without reagents have been carefully noted. The results thus obtainable are absolutely necessary for the interpretation of the lesions observed, or supposed to be observed, in sections of hardened portions.

Among the pathological specimens forwarded to me for examination were several pieces of spinal cord; and Dr. McConnell cut sections from the lumbar region of the two which appeared best preserved. In all these sections I found a peculiar abnormal condition, which I think necessary to mention, although I have grave doubts as to whether it can be regarded as a lesion produced by yellow fever. Scattered through all parts of the sections, but most abundant in the white matter of the cord, there were considerable numbers of peculiar rounded or oval bodies, from two to five thousandths of an inch or more in long diameter. They appeared under a two-thirds objective, in the balsam-mounted sections, as colorless spaces, empty, or filled with delicately-granular contents. With a good immersion lens (one-fourth to one-eighth) the granular character of the masses was more distinctly seen, and some of them appeared to be encapsuled with a layer of nucleated connective tissue resembling condensed or compressed neuroglia.

With regard to the actual significance of these bodies, I am not prepared to offer any positive opinion at the present time. If they are the product of a degenerative change taking place during life, the process is certainly not peculiar to yellow fever. They appear to be very like the granular masses sometimes found in thin sections of the brains of the insane, as shown in some of the microphotographs reproduced and described by Dr. John P. Gray in 1874.† Similar appearances in the spinal cord have been figured by Dr. E. L. Fox, in a plate labeled "Gray degeneration of the cord."‡ I may add that there are in the microscopical cabinet of the Army Medical Museum sections of the brain of a man dead of tetanus, and of the spinal cord of a horse dead of epidemic catarrh, in which there are numerous rounded or oval bodies identical in appearance with those found in the sections of cord from the yellow-fever cases; and

*I understand from the context that all these observations were made only on preparations hardened first in bichromate of potassa.

†JOHN P. GRAY. *Pathology of insanity*, Amer. Jour. of Insanity, July, 1874, p. 1. I refer particularly to Plate A, Figs. 1 and 2, Plate C, Fig. 2, and Plate E, Fig. 2.

‡E. L. FOX. *The pathological anatomy of the nervous centers*, London, 1874. Plate VIII, p. 114.

the same is true of some sections, in the same collection, of the spinal cord of an apparently healthy cat, killed for dissection.

I entertain a strong suspicion that in many cases such bodies as these are merely the result of post-mortem changes, and have no pathological significance, but am not now prepared to insist upon this view, to establish or disprove which would require a somewhat laborious series of experiments.

The sympathetic ganglia.—Dr. S. A. Cartwright, of Natchez, claimed in 1826 the merit of the "discovery" that in yellow fever the delicate tissues involving the whole ganglionic system of nerves were more or less inflamed. He asserted that he had found this condition in the cardiac, pulmonary, mesenteric, renal, and hepatic plexuses, but that "the semilunar ganglions and the cœliac plexus were in particular highly diseased." Dr. C. Belot, of Havana, in 1865, revived this statement, so far as the ganglia of the solar and cœliac plexuses were concerned, with the additional remark that he found them softer than normal, so that when compressed between the fingers they were easily mashed.

These assertions have served to suggest the microscopical examination of the sympathetic ganglia. Dr. Schmidt reports that he has made and examined thin sections of some of these ganglia in five cases. "The ganglia chosen for examination were those of the solar plexus, especially the semilunar, together with the first thoracic, or ganglion stellatum." In two cases he found that the nuclei of the ganglion-cells had "disappeared, though the nucleoli were left behind"; and he thinks this was probably due to fatty degeneration. In another case there was an abnormal accumulation of pigment in the ganglion cells; in the rest he detected nothing abnormal. As for the minute blood-vessels, although they were congested in some cases, they were empty in others.

Dr. J. Guiteras, of the Havana commission, examined the semilunar ganglion microscopically in three cases, and reports that he found cloudy swelling of the nervous elements, and that "connective tissue of new formation" was met with to a still greater extent than in the liver and kidneys of the subjects he dissected.

Among the balsam-mounted preparations by this gentleman I found several carmine-stained sections of the semilunar ganglia of subjects dead of yellow fever, which show the structural details quite well. These I have examined with care, and critically compared with some sections prepared by Dr. McConnell, at the museum, from the semilunar ganglia of human subjects dead of other diseases. This comparison has forced me to the opinion that the preparations of Dr. Guiteras do not really exhibit any abnormal condition. It is well known that the individual nerve cells of each lobule of the large sympathetic ganglion are held together by a dense connective tissue, which, indeed, has been described as forming a separate capsule for each nerve cell. In balsam-mounted sections of such lobules, large numbers of oval nuclei belonging to this connective tissue can be observed; but these appeared to be quite as numerous in the sections prepared at the museum as in those from the yellow-fever subjects. Moreover, the indistinctness of the nuclei of the ganglion-cells, mentioned by Dr. Schmidt, did not exist in the preparations of Dr. Guiteras. These nuclei appeared to me fully as distinct as the nucleoli, and both were readily defined with an immersion one-fourth, wherever the sections were thin enough to give a satisfactory view of the cells.

2. *The heart and blood-vessels.*—A fatty degeneration of the muscular fibers of the heart was described by Professor Riddell, of New Orleans, in his account of the microscopical observations made by him during the epidemic of 1853.* This condition has since then been emphasized by several investigators, among whom I may mention especially Dr. Joseph Jones and Gama Lobo, but others have failed to recognize it. Lawson declares that he never saw an instance of it, but he did not regard the condition of the cardiac muscle as normal. He found the fibers pale, with indistinct transverse striæ, and an abnormal disposition to separate longitudinally into their component fibrillæ; there was also a certain haziness or loss of definition in outline, affecting both the fibers and the blood-vessels between them, and he thought he recognized the presence of an exudation in the cardiac tissue similar to that he believed to exist in the kidneys, liver, and brain. J. Crevaux in 41 autopsies, made very soon after death, found the heart quite firm in 39. Four of these cases he examined microscopically, but sought in vain for any traces of fatty degeneration; on the contrary, the transverse striæ were perfectly distinct. In like manner Dr. J. Guiteras was unable to discover this lesion in any of the autopsies he made at Havana. He found the heart normal in consistency and color, its striations always distinct, and only in some of the fibers were a few fatty granules seen in the neighborhood of the nuclei. I may remark that the striations of the cardiac muscular fibers are very plainly seen on several of the balsam-mounted preparations made by this gentleman, and that none of them exhibit any appearances which can be interpreted as due to fatty degeneration. This lesion, therefore, cannot be regarded as by any means constantly present in yellow

*La Roche, Vol. I, 392.

fever, but this by no means proves that it does not occur in certain cases, perhaps in certain groups of cases; only the unskilled observer must be careful not to mistake for it the granular appearance produced by cardiac changes, and must bear in mind that the transverse striations of the cardiac fibers are normally less distinct than those of the voluntary muscles, as well as the circumstance observed by Kölliker, that small fat granules in the vicinity of the nuclei are habitually found in the cardiac fibers after death.*

Certain lesions are also said to have been recognized with the microscope in the minute blood-vessels. It is well known that one of the characteristic features of this disease is the marked tendency to hæmorrhages. Besides external hæmorrhages, such as black vomit, bloody sputa, bloody urine, &c., internal hæmorrhages are of frequent occurrence. They are found in the form of apoplectic infarctions of the lungs, the intermuscular connective tissue, &c.; but still more frequently as minute hæmorrhagic spots, resembling petechiæ or ecchymoses on the surface of various internal organs, or scattered through their parenchyma. It seems to be pretty clear that the appearances last mentioned, as well as the others, are due to actual hæmorrhages, and not merely to a transudation of the coloring matter of the blood; but the nature of the abnormal condition of the vascular wall that favors these hæmorrhages is by no means established. The statement of Lawson that in various other organs, as well as the brain, the nuclei of the walls of the minute blood-vessels are abnormally numerous has not been supported by subsequent observers. More probable appear the accounts of those who, like Crevaux, Gama Lobo, and Schmidt, believe they have observed a fatty degeneration of the walls of the capillaries and small vessels of this or that organ. This view agrees with the general belief in a tendency to fatty degeneration in various other organs, especially the heart; but the accounts referred to are by no means so complete that they can be regarded as settling the question, so that further researches are desirable.

3. *The stomach.*—The stomach of subjects dead of yellow fever usually contains a greater or less amount of black vomit, and the microscopical examination of this fluid is the more important because the columnar epithelium of the gastric mucous membrane desquamates so soon after death that in most cases the condition of its elements can only be observed by examining the fluid contents of the organ. Although it has been stated that occasionally the mucous surface of the stomach presents no abnormal appearance, or is even paler than natural, yet in the great majority of yellow-fever cases it is more or less congested, often intensely so; ecchymotic spots are frequently observed on its surface, occasionally hæmorrhagic erosions, and even it is said ulcerations. The nature of the process giving rise to these appearances has been the subject of some discussion. The most generally accepted view, based in part upon what is seen by the unaided eye, in part upon the symptoms of the disease, is that we have here to do with an acute gastric catarrh of variable intensity; but the correctness of this view is by no means so fully supported by exact histological observations as could be desired. Indeed, several of the most recent investigations appear to be opposed to this view. Among these may be mentioned those of J. Crevaux, according to whom the most important lesion is a fatty degeneration of the cells that line the gastric glands and of the capillaries of the mucous membrane. By the latter lesion he explains the hæmorrhage that gives the black vomit its character.

The appearances observed by Dr. Schmidt are interpreted by him as representing simply a venous congestion, the consequence of previous disturbance in the circulation of the liver. He has given some interesting details with regard to this congestion. It is well known that the mucous membrane of the stomach is the seat of a fine capillary network, the meshes of which surround each of the several gland-tubes. These empty into a fine plexus of venules situated near the surface of the mucous membrane, just beneath its epithelium. From this plexus, at intervals, rather larger veins originate which descend perpendicularly between the gastric glands to join the plexus of still larger vessels in the submucosa.† Now, according to Dr. Schmidt, the congestion of the gastric mucous membrane is seated in the superficial venous plexus; it is not uniformly diffused, but exhibits numerous small red centers or spots corresponding to little territories immediately around the places at which the small veins just mentioned descend perpendicularly through the mucous membrane. The centers of congestion he regards as undoubtedly the spots from which "the hæmorrhages known as black vomit proceed." He mentions further that he observed free hæmoglobulin in the "epithelial and glandular cells" surrounding the congested venous radicles. Dr. J. Guiteras declares as the result of his observations that "the stomach presents no evidences of inflammation. The protoplasm of the epithelial cells is normal, and the nuclei quite distinct." Having made his autopsies so long after death, he not unnaturally complains that he found in most of his preparations that "the tops of the ridges between the gastric follicles are removed by post-mortem digestion." In some of them, however, these ridges remained, and then he detected in them small hæmorrhagic in-

*A Kölliker—*A Manual of Human Microscopic Anatomy*, London, 1860, p. 478.
†See C. TOLDT in STRICKER'S *Manual of Histology*, Amer. Ed., New York, 1872, p. 403.

farctions close under the free surface of the mucous membrane. Dr. T. E. Satterthwaite, however, who exhibited last October to the New York Pathological Society a number of microscopic slides from a woman who died of yellow fever at the Presbyterian hospital, July 29, 1879, is reported to have observed in the stomach-sections appearances corresponding in some particulars to those that occur in gastric catarrh: "The epithelia of the mucous and peptic glands were thought to be abnormally granular. At the mouth of the follicles the epithelium was frequently wanting, and in them were seen in places lymphoid corpuscles. There was neither congestion of the stomach nor extravasation of blood. The connective tissue seemed increased in amount."

From an examination of the sections mounted by Dr. Guiteras, and of those prepared from the fragments of stomach received at the Museum, I can fully corroborate the statement of that gentleman that all these specimens had suffered more or less from post-mortem changes. The distribution of the venous congestion, so far as it could be made out, corresponded closely to the description given by Dr. Schmidt. If such changes as fatty degeneration of the capillaries of the mucous membrane or of the cells lining the tubular glands had existed, they were no longer recognizable, and, except in two particulars, the sections did not appear to differ from those cut from normal stomachs in which post-mortem changes have fairly set in. The first was the characteristic congestion, the second was the presence in some of the sections of a number of elements resembling wandering white-blood corpuscles. The latter were seen in the vicinity of some of the veins descending perpendicularly through the mucous membrane, and group-wise in other places, especially toward the bases of the tubular glands. These observations are, of course, entirely inadequate to determine the frequency and significance of the lesion just named; and it may be added that none of the researches hitherto reported deal satisfactorily with the question of the changes occurring in the gastric mucous membrane, except so far as concerns the anatomical relations of the congestion that determines the gastric hæmorrhage, so that the whole subject of the histological conditions of the mucous membrane itself rexuires further investigation.

4. *The liver.*—Since the publication of the observations of our fellow-countrymen. Drs. Alonzo Clark, T. H. Bache, and Joseph Leidy,* the hepatic lesion in yellow fever has been most generally regarded as essentially a fatty degeneration of the organ. Dr. Leidy compared the condition of the hepatic cells to that observed in the fatty livers of drunkards and consumptives. They "were unaltered in form and structure from the normal condition; but they differed in having deposited in their interior a variable amount of oil globules, frequently entirely obscuring the nucleus, which, however, was rendered readily visible on the application of acetic acid. The oil globules varied in size from a small granule to the one-half the diameter of the containing cells, and many of those observed loose in the field of the microscope, which had escaped from lacerated cells, ran together and formed drops larger than the cells." Those subsequent observers who have not contented themselves merely with recognizing this condition may be divided into two groups: The first have endeavored to make out the preliminary morbid processes that precede the fatty metamorphosis; while the second have thought they observed in the advanced stages of the disease certain additional characteristic changes.

That the fatty degeneration of the liver is a lesion developed after the commencement of the disease seems to be pretty well established, as is also the circumstance that the degree to which it is present at any given stage of the fever varies in different individuals and different epidemics. The livers studied by Dr. Leidy were described by him as varying in color from a "yellow clay-like hue to a brownish-orange;" but other equally careful observers have described yellow-fever livers as brown, chocolate color, or the color of café au lait, and between these hues and the brighter yellows various intermediate tints have been noticed. In yet other cases the liver has been found purple, livid, or engorged with blood; and the assertion of some of the older observers that it may even exhibit no recognizable deviation from its normal color and texture has been repeated from time to time to the present day.† It may, perhaps, be doubted whether these apparently normal livers would have sustained the test of careful histological examination, but the occasional occurrence of a highly congested state of the organ is supported by some of the most recent anatomical investigations. Thus, J. Crevaux, during the epidemic of 1877 in French Guiana, found, particularly in cases that died very early, manifest congestion of the parenchyma of the liver, accompanied by ecchymotic spots on its surface. Microscopical examination showed that this congestion had its seat in the interlobular (portal) veins, and not, as in the so-called "nutmeg liver," in the intralobular (hepatic) veins. When death took place later in the disease, however, he always found the liver more or less yellowish, and then its parenchyma exhibited under the microscope a corresponding degree of fatty degenera-

* La Roche, Vol I., p. 404.

† Thus, for example, Carl Heinemann remarks, "In gar nicht wenigen Fällen die Leber vollkommen frei von Veränderungen angetroffen wird." See p. 171 of his essay, cited at the close of this paper.

tion. He concluded, therefore, that in the ordinary course of yellow fever a stage of congestion precedes the fatty degeneration of the organ.

This view, which has been accepted by Bérenger-Féraud and other subsequent writers, is supported by some of the observations of Dr. H. D. Schmidt, who states that in epidemics previous to that of 1878 he has sometimes observed parts of the liver congested, while other parts were fatty, and others even normal. The congestion was usually confined to the interlobular vessels, but he observed the "nutmeg" condition also in a limited number of cases. In the autopsies he made during 1878, however, he invariably found the whole liver fatty, and usually in a high degree. Dr. Schmidt, however, describes certain particulars in which the yellow-fever liver differs from the common fatty liver. Although he made his autopsies quite soon after death (three-quarters of an hour to three or four hours), he noticed that the hepatic cells were stained by carmine and other coloring matters with difficulty, and this he attributes to a "commencing degeneration of their protoplasm"; moreover, he states that he recognized the presence of extravasated hæmoglobulin, with or without associated bile-pigment, in the hepatic cells, "in the vicinity of the ultimate branches of the blood-vessels" of the organ.

Other observers, both earlier and later than he, have believed they detected with the microscope something more than mere fatty degeneration in the yellow-fever liver. Unfortunately, however, the testimony in this direction is by no means harmonious. Lawson, who recognized fatty degeneration of the liver in a part at least of his cases, held (1862) that there is in yellow fever an active exudation into the parenchyma of the organ, embracing the minute bile-ducts, and closing them to the passage of the bile. He also found the interlobular connective tissue abundant, opaline, and containing more or less exudation and granular matter, while the minute arteries and veins "were covered with closely-set nuclei and granules." With this account may be compared the brief description by Bonnet (published in the work of Bérenger-Féraud) of two microscopic sections of the liver of a patient who died of yellow fever during the epidemic of 1877 in French Guiana. They are said to have exhibited thickening and slight sclerosis of the perivascular connective tissue, while cloudy swelling (tuméfaction troublé) was uniformly associated with the fatty degeneration of the cells of the hepatic lobules. Still more marked were the lesions in the interlobular spaces observed by Lebredo in two livers sent in alcohol from Havana to Paris during the year 1877. Besides a fatty degeneration of the parenchyma of the hepatic lobules, in which the capillaries were collapsed, and contained almost no blood, he found unmistakable evidences of the form of cirrhosis described by Charcot and Gombault under the designation of cirrhose en îlots.* He prudently regarded this cirrhosis as an ancient process, long antedating the fever; but conjectured that certain groups of leucocytes observed in the hypertrophied interlobular connective tissues, especially around the biliary canals, were evidences of an acute process occurring during the fever. In the case reported by Dr. T. E. Satterthwaite somewhat similar lesions were observed. Many of the liver cells were in an advanced stage of fatty degeneration, while others were more granular than normal, and it was with difficulty that any nucleus could be recognized. "There was also a marked increase in the connective tissues of the organ, and in places the separate cells were surrounded by new formed connective tissues, as has been observed in syphilitic cirrhosis. Dr. J. Guiteras, of the Havana commission, found one of the livers he examined affected with cirrhosis, which, however, he regarded as a pre-existing chronic process, holding that the lesion characteristic of the yellow-fever liver is "the so-called parenchymatous inflammation of Virchow. The hepatic cells are in a condition of cloudy swelling." At times, however, they show "evidences of fatty degeneration and pigmentary infiltration." Certain modifications in the connective tissue of the organ accompanied these changes; he thought it swollen, and that it presented some embryonal cells.

By yet another group of observers the hepatic lesion in this disease has been regarded as similar to that which characterizes acute yellow atrophy of the liver, or even as identitical with it. This view was especially insisted on by Liebermeister in his essay on parenchymatous degeneration of the liver, although he admitted that it was by no means established by adequate microscopical observation. These Adolfs Schmidtlein has attempted to supply from studies made in 1865 at Vera Cruz. He states that he found the hepatic cells quite destroyed, and, in this and other particulars declares that the histological changes observed fully corresponded with those described by Liebermeister as occurring in acute yellow atrophy. With this statement may be associated the observations recently reported by Guichet. This military surgeon brought back from Madrid, in 1878, pieces of two yellow-fever livers, which were investigated by M. Sabourin in the laboratory of Professor Charcot.† M. Sabourin reports that

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*Charcot et Gombault. Contributions à l'étude anatimique des defférentes formes de la cirrhose du foie. Archives de Physiologie, 1876, p. 453.

† A piece from a third liver was presented for examination to the laboratory of Vulpian. Fatty degeneration was recognized, but the piece was in such a state of cadaveric alteration that thorough investigation was impossible.

he found the hepatic cells affected by two intimately-associated lesions: 1. Fatty degeneration. 2. "Fragmentation granuleuse." The latter process (which, according to him, is the most important, the former being only accessory to it) he describe as follows: "The protoplasm of the cell breaks up (*se fragmente*) into several irregular blocks, which refract light a little more than the normal protoplasm; then the nucleus of the cell disappears." The ultimate result is to convert the lobule into a "magma" of fragments.* Simultaneously a certain number of the cells undergo the process of ordinary fatty degeneration, being ultimately transformed into vesicles filled with oil, and in stained preparation, the peripheral nuclei of these vesicles, as well as the nuclei of the hepatic capillaries, can be recognized in the midst of the magma of fragments mentioned above.

Two of the observers cited have recognized, in addition to the lesions described, the presence of small collections of bacteria in sections of yellow-fever livers. Dr. Schmidt relates that he found them only in the cuts from a single piece of liver, which he afterwards remembered he had found floating in the solution of bichromate of potassa employed to harden it. He attributes the floating of the piece to germs developed by commencing putrefaction, and supposes the bacteria to have been developed at the same time. Dr. Satterthwaite is reported as stating that in sections of the liver he examined "collections of bright little bodies of uniform size" were found. "They were bacteria and seemed to be in the blood-vessels." According to the report of his remarks, "It was stated by Dr. Satterthwaite the presence of bacteria in the specimens could be explained in various ways, and he did not believe that it in any way sustained the notion that these organisms produced the disease. Accumulations of bacteria of similar apperaance he had found in persons suffering from other diseases not contagious or infectious." It should be added that Dr. Guiteras, of the Havana Commission, sought in vain for low organisms in the specimens he examined. "No microphytes have been found," he writes, "in the liver or the blood contained in its vessels."

I do not feel myself in a position to submit the foregoing diverse accounts of the hepatic lesions in yellow fever to a criticism guided by personal observations, and must content myself, therefore, in this place with a brief statement of what I was actually able to observe in the sections mounted by Dr. Guiteras and those prepared at the Army Medical Museum from the pieces of yellow-fever livers sent me for examination. So far as I was able to observe, the most prominent lesion exhibited in the majority of these sections was fatty degeneration of the cells of the hepatic parenchyma. In the balsam-mounted specimens, it is true that the fat, which had been dissolved out by the previous action of alcohol and benzole, was no longer visible as such, but the characteristic vacuoles left after its solution were readily observed in almost all the cells examined, and did not differ in appearance from those seen in sections of ordinary fatty livers similarly prepared. The stage to which this fatty degeneration had advanced differed somewhat in the several livers examined, but in none of them had it attained a very high degree. The cells usually contained from one to six or eight vacuoles, the largest of which seldom much exceeded the cell-nucleus in size; rarely did I see cells occupied by a single colossal vacuole, such as are so commonly observed in balsam-mounted sections of livers in which the process of fatty degeneration is far advanced. The protoplasm between the vacuoles in the individual hepatic cells was reduced in quantity in proportion to the number and size of the vacuoles. It was yellowish in color, and seemed to break and tear very easily, at least the number of broken cells at the edges and in thin portions of the sections was larger than in ordinary fatty livers; but the lines of fracture seemed to be determined only by the arrangement of the vacuoles, and I could recognize nothing corresponding to Sabourin's description of "fragmentation granuleuse." The arrangement of the hepatic cells in chains radiating from the central venous radicle to the periphery of the lobule was not as clearly displayed as usual, and the preparations exhibited throughout a certain indistinctness closely resembling the familiar alterations of incipient putrefaction; moreover all the sections were found to be very difficult to stain with carmine, and in some of them no discrimination of the nuclei could be obtained in this way, another particular corresponding with the ordinary putrefactive processes. I readily verified in the sections prepared by Dr. Guiteras his statement that one of the livers he had examined was affected by chronic cirrhosis, and among the pieces of liver transmitted to me I found one from another case that exhibited the same lesion in a still higher degree. In both these livers the cells of the hepatic parenchyma presented conditions very similar to those just described, and in addition to this, in both an abundant infiltration of cells resembling leucocytes was observed, not merely in the abnormally developed interlobular connective tissue, but also in the parenchyma of the lobules. Except in these two livers, however, I was quite unable to recognize any pathological condition of the interlobular connective tissue, or of the vessels and bile ducts imbedded in it. I found no infiltration of cells resembling leucocytes either here or in the hepatic parenchyma; nor did I succeed in discovering low vegetable forms in the blood-vessels or other parts

* This description closely resembles that of acute yellow atrophy of the liver by CORNELL and RANVIER.—*Manuel d'Histologie Pathologique*, 3me partie, Paris, 1876, p. 889.

of any of the sections. Evidently these observations are quite insufficient to solve the vexed questions relating to the hepatic lesions in yellow fever. According to a memorandum transmitted with the specimens, the patients from whom they were derived all died on the fourth, fifth or sixth day of the disease.* No written memorandum of the appearances of the livers was furnished, but I was told verbally by Surgeon Sternburg that they all presented the *café-au-lait* color. Marked fatty degeneration had occurred in them all, and they therefore throw no light on the morbid conditions that antedate this change. On the other hand, the extent to which the fatty degeneration had advanced in these livers affords evidently no indication with regard to the possible degree of the process in the livers of more protracted or more malignant cases.

As for the important questions relating to the associated lesions by which the yellow-fever liver probably differs from the ordinary fatty liver, I do not believe they could be solved merely by the study of sections made from pieces hardened in alcohol or other preservative fluids, even if the autopsies that furnished the specimens were made immediately after death. Is the yellow color of the protoplasm of the hepatic cells due to biliary coloring matter, the coloring matter of the blood, or both? Is the alleged fragmentation of this protoplasm a mere post mortem change, or a process that can be fairly recognized in livers examined immediately after death? Can any other abnormal changes than these heretofore described be observed in this organ? To answer these questions in a trustworthy manner will require not merely the investigation of fresh livers, as soon as possible after death, and a comparison of the appearances thus observed with those seen in carefully made sections from pieces of the same livers hardened in different ways, but it will be necessary to examine in this manner a considerable number of livers from subjects dying at different periods of the disease, including its earlier as well as its later stages, and probably to compare the conditions detected in those dead from endemic yellow fever with those found in the victims of severe epidemics. One further consideration, suggested by the previous literature of the subject, is emphasized by the specimens collected by the Havana Commission. It is very evident that yellow fever does not spare those who are already suffering with diseases of the liver, and, as these are of frequent occurrence in hot climates, the histologist who deals with the questions under consideration must be continually on his guard lest he confound lesions resulting from some pre-existing hepatic diseases with those dependent on the fever.

5. *The kidneys.*—The great frequency of albuminuria in this disease has long directed attention to the condition of the kidneys; yet our knowledge of the minute changes in these organs is perhaps more incomplete than in the case of the liver and stomach; and the comparison with Bright's disease, early suggested by the mere fact of the presence of albumen in the urine, has added comparatively little to our knowledge, since, under this head, a variety of lesions are undoubtedly embraced. Alvarenga reports that in the Lisbon epidemic of 1857 the cortical substance of the kidneys was often found to be considerably swollen, and appeared to the naked eye to be fatty, as on microscopical examination proved to be the case. Haenisch remarks: "It is reported by almost every one that a swelling of the cortical substance, with partial fatty degeneration, is very often present." And in fact the general conception that the characteristic change in the kidneys, as in the liver and other organs, is a fatty degeneration has been pretty widely accepted.

Additional particulars, which are by no means fully accordant, have, however, been contributed from various sources. Lawson not merely found the epithelial cells of the tubuli very granular, their nuclei and outlines being indistinct, but thought the connective tissue of the organ seemed swollen and infiltrated with an opaline exudation. Moreover, the nuclei of the minute blood-vessels, including the loops of the Malpighian bodies, were abnormally numerous, and altogether he regarded the microscopical appearances as indicating "an active exudation into the parenchyma of the organ, and a catarrhal affection of its mucous surfaces." In one case he observed a deposit of pigment "in the form of minute granules," which covered the epithelium at intervals along the convoluted tubes. According to Dr. Joseph Jones, "when thin sections of the kidneys are examined under the microscope, the Malpighian corpuscles and tubuli uriniferi are found to be filled with granular albuminoid and fibroid matter, excreting cells detached and oil globules." J. Crevaux presents a view in harmony with his account of the pathological changes in the liver. When the duration of the disease has been short the kidneys are manifestly congested, and ecchymosed spots are observed in the cortical substance of the organ as well as beneath the capsule and on the mucous lining of its calyces and pelvis. In the cortical substance little globular hæmorrhagic spots the size of a pin's head were frequently observed, and turned out to be the capsules of the Malpighian bodies distended with blood. In one subject the central portion of some of these hæmorrhagic foci had softened into a pus-like fluid. Such little hæmorrhagic and purulent foci (*petits foyers sanguins ou purulents*) were observed by Chapuis more than twenty years ago in the kidneys of

* Case 17 is said to have died on the third day, but I received neither mounted sections nor uncut fragments from the liver.

subjects dead of yellow fever. These preliminary lesions are succeeded by a fatty degeneration of the parenchyma of the organ. To the naked eye it appears of a whitish or grayish yellow color; under the microscope the cells contain large oily globules and fine granules. According to Rey, hæmorrhagic foci in the cortical substance of the kidney were observed also by Gama Lobo, in whose cases, however, they appeared to have co-existed with fatty degeneration of therenal epithelium.

Dr. J. G. Richardson is reported to have found the uriniferous tubules of the kidney clogged with low vegetable forms. But the appearances on which this view was possibly based are differently interpreted by Dr. H. D. Schmidt, who regards the characteristic kidney lesion as a granular degeneration preceded by hyperæmia, and ultimately advancing to fatty degeneration. In some of the cases he examined, a few of the tubules were "blocked up by short albuminous cylinders of a yellow color." In other cases "the cells of the epithelium of the uriniferous tubules were observed to disintegrate, and the granules of the cells, set free by the degeneration of the protoplasm, to collect in opaque masses apparently held together by mucus." Dr. T. E. Satterthwaite is reported to have described the condition of the kidneys in the case examined by him as follows: "On microscopic examination the epithelium throughout the kidney was swollen and intensely granular. The tubes contained numerous small granular casts of a yellowish color. At the apices of the pyramids the collecting tubes were nearly stripped of epithelium. The epithelium that remained was intensely swollen, and even more granular than in other parts of the kidney. At several points the tubes, and in some cases the blood-vessels, were blocked with numerous little bright bodies of a uniform size, arranged in a regular manner at equal distances from one another. They looked at first like spherical bacteria, but on close examination with high powers (immersions 1-10, W. Wales, and No. 12 Prazmowski) the bodies proved to be mostly, if not wholly, rod-bacteria of the usual kind." In this connection it is proper to add that the patient died July 29, and that the autopsy is said to have been made twenty-one hours after death. Dr. J. Guiteras on the other hand reports that he found no organisms in the kidneys of the cases he examined at Havana. The cells of the renal epithelium were more or less in a state of cloudy swelling; but in every kidney some of the tubules appeared to be normal; in others he found evidences of catarrhal inflammation; not infrequently he observed yellow casts choking up the caliber of the tube; sometimes the tubules contained coagulated blood. The blood-vessels, especially of the cortex, were frequently distended with blood.

The appearances I was myself able to recognize in sections mounted by this gentleman and those prepared at the museum from the fragments of kidneys submitted were, briefly, as follows: Not merely did the cells of the convoluted tubules in the cortical portion of the kidney appear to be swollen, and more than usually granular (how much of this latter condition was due to post-mortem change I know not), but in some of the sections the fact that fatty degeneration of the organ had commenced was clearly established by the presence in the protoplasm of these cells of the characteristic vacuoles from which the fat had been dissolved by the reagents used in preparing the sections for mounting in balsam. In some of these tubes the epithelial elements had become detached and lay free in the lumen. Others were occupied by one of two kinds of casts, yellow transparent ones resembling those called "waxy," and more or less coarsely-granular casts, the latter being by far the most numerous. In the cortical portion of the organ some of these casts, in the pyramids most of them, occupied the lumen of tubes, the epithelium of which was quite intact. The granular casts were certainly not collections of low vegetable forms, for, notwithstanding the length of time they had been immersed in alcohol, they dissolved, as did the waxy casts, in a solution of caustic potash. On the other hand it was very evident in some places that considerable numbers of red-blood corpuscles were imbedded in their substance, but in the condition of the specimens I was unable to form an opinion as to the actual share taken by mere hemorrhage in their formation, or as to their relationship to the waxy casts, or to the detached epithelium observed in some of the convoluted tubes.

The two forms of casts observed in the tubules of the kidneys in these cases correspond with the descriptions of the two varieties found in the urine during life, and it is evident that the latter should be studied with the former. It will furthermore readily be understood that the remarks made in connection with the liver as to the importance of the further investigation of specimens taken as soon as possible after death in different stages and forms of the disease fully apply to the kidneys also. Among recent studies of the pathological history of some of the ordinary forms of Bright's disease I may particularly mention the essays of T. Langhans, of Bern, and V. Cornil, of Paris,* as examples of fruitful researches which could not have been con-

* T. LANGHANS. Ueber die Veränderungen der Glomeruli bei der Nephritis nebst einigen Bemerkungen über die Entstehung der Fibrincylinder. Virchow's Archiv, Bd. 76, 1879. S. 85.

V. CORNIL. Nouvelles observations histologiques sur l'état des cellules du rein dans l'albuminurie due à la nephrite parenchymateuse et la nephrite interstitielle. Journal de l'anotomie et de la physiologie, année xv, 1879, p. 402.

ducted had not fresh material been at the disposal of the investigators. Langhans obtained his best results by comparing the appearances observed in recent preparations macerated a short time in bichromate of potassa, and teased out, with those seen in carefully made sections, while Cornil gave the preference to sections made from pieces of kidney hardened with osmic acid—a method which, as is well known, requires the freshest possible material to produce serviceable preparations. That the conclusions arrived at by these able histologists differ in so many important details may serve to illustrate the difficulties with which studies of this kind are beset; but I have been led by a perusal of the papers to an opinion that the methods of both should be included among those employed in the investigation of the yellow-fever kidney. The osmic-acid method is also to be commended as a means of determining with some precision the extent to which fatty degeneration has advanced in the renal epithelium, for which purpose it may advantageously be employed in the study of the liver and other parts affected, or supposed to be affected, by fatty degeneration.

Lesions observed in other organs.—It is not necessary for the purpose of the present paper to discuss the various other lesions that have been observed in this disease; they are, for the most part, either accidental concomitants of individual cases, or have been, as yet, so imperfectly studied that their insignificance is quite doubtful. As an illustration of the latter class of observations I may refer to the granular condition of the suprarenal bodies observed more than twenty years ago by Chapuis, and the fatty infiltration or degeneration of the same organs recently described by Dr. H. D. Schmidt.

CONCLUDING REMARKS.

Enough has been said, I trust, in the foregoing pages to show that we have yet a great deal to learn with regard to the pathological histology of yellow fever. The importance of further studies in other directions also, such as the chemical investigation of the blood and excreta, the microscopical and chemical investigation of the drinking water and the air, the accumulation of additional facts with regard to the circumstances under which the disease occurs, and the manner in which it spreads from place to place—all this is willingly conceded, but does not lessen in the least the urgent need of further histological studies to reconcile discordant observations and clear up so many doubtful points.

One further suggestion appears to be needed: It may be admitted that little or nothing is to be expected from additional autopsies in which the macroscopic appearances only are observed and recorded; but it is not for that reason unnecessary that these appearances should be critically noted whenever serious histological inquiries are to be undertaken; and under the same circumstances it is also important that the clinical phenomena should be studied with the greatest care. It is essential to our ultimate comprehension of the disease that the minute textural lesions of individual tissues and organs should be connected by actual observation with the changes recognizable by the naked eye, and with the several symptoms that occur during the progress of the malady. A good clinical history and a detailed record of the appearances observed during the autopsy appear to me, therefore, of the highest importance in every case selected for further histological researches.

In conclusion, let me express the hope that the suggestion made in the early part of this paper with regard to the training, at the expense of the general government, of one or more experts for the prosecution of this important inquiry may be found practicable. Our relation as a nation to this disease is quite unlike that in which we stand to most other maladies. It is constantly present at our very door, and constantly threatening to spread devastation among our people as it has recently done; but it is brought into no such close and threatening relations with those European nations who have been recently most successful in investigating the pathological histology of other diseases that they are likely soon to make it the subject of an exhaustive study. Nor have we much to expect, I suppose, from any inquiries the physcians of Cuba, Mexico, or other American countries south of us are likely soon to undertake. On the contrary, it seems in every way probable that if anything of value is to be done in this direction we must arrange to do it ourselves. That the means may be found for putting at least one zealous and competent inquirer into the field at an early day is to be earnestly hoped.

Very respectfully, your obedient servant,

J. J. WOODWARD,
Surgeon, United States Army.

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APPENDIX K.

CLIMATE AND DISEASES.

BY CLEVELAND ABBE, M. D.

I. Having been requested by the president of the National Board of Health to present a few remarks "on the possible relations between meteorological data and vital statistics, and especially on the graphical method of presenting this data," I have therefore given this subject some consideration, and by way of an introduction to your deliberations submit the following remarks and suggestions with much diffidence, as coming from one who can have no claim to being an expert in these matters. The subject, indeed, is by no means a new one, but possesses rather a very long list of authors and titles, to all which I need not now refer.

Now, I shall not pretend to review the literature of the subject or to review all our knowledge of the relations of meteorology to health, but I shall assume that we, to-day, desire only to consider how far the study of climate may be reasonably expected to assist the physician in determining the ultimate cause of diseases and in applying the remedy. I must, therefore, first speak of a few hazy and imperfect or wholly erroneous ideas that must be cleared away before we can decide what is at present demanded of us by way of observation, and what graphic or statistical methods are to be recommended. These erroneous views on the relations of climate and health may seem hardly worth combating, but you will see that they have been so extensively repeated by eminent writers that it may well be feared lest the search after the truth has been long delayed by such dissemination.

II. I will first remark that there certainly has for ages been prevalent an opinion that certain climates are beneficial to invalids, and the sick have been transported thither with good results. But in doing this it has all along been quietly implied, and by many well understood, that the beneficial effects were due not to the climate in itself but wholly to the influence on the patient of *a change of climate*, if not indeed to other wholly extraneous conditions, such as bathing, freedom from dust, malaria, &c.

The numerous geographical and statistical comparisons that have been collected by so many students of this subject have, so far as I have examined them, nothing in them to show conclusively that the annual average temperature, moisture, wind, pressure, cloudiness, sunshine, &c., have in themselves anything more than an infinitesimal influence upon health, disease, or death, and yet these statistical authors have frequently lost sight of the distinction between the effect of a uniform climate and of a very changeable one, or rather, to be more charitable, they found the statistical material at hand in a shape that rendered it too laborious or impossible to separate the changeable from the uniform.

As an illustration of this very common class of errors, I will quote from a well-known author (Dr. Fox, of London), who, in his little pamphlet on the humidity of the air of Scarboro, formulates the connection between humidity and health, as follows:

First. A preternaturally dry air, with a high temperature, is apt to give origin to fevers and intestinal disorders.

Second. A very moist atmosphere, accompanied by a low temperature, predisposes to bronchial and rheumatic affections.

Third. A very dry atmosphere, when associated with a low temperature, excites inflammations of the respiratory organs.

Fourth. Humid climates and excessive rainfall, by producing a damp, foggy, relaxing climate, exert an injurious influence on the health, depressing the nervous system and checking the cutaneous and pulmonary exhalations.

Fifth. Abundant rainfall diminishes cholera, diarrhœa, and typhoid fever.

These and similar statements illustrate the difficulty of our subject, and show how easy it is to confound causes, effects, and concomitants.

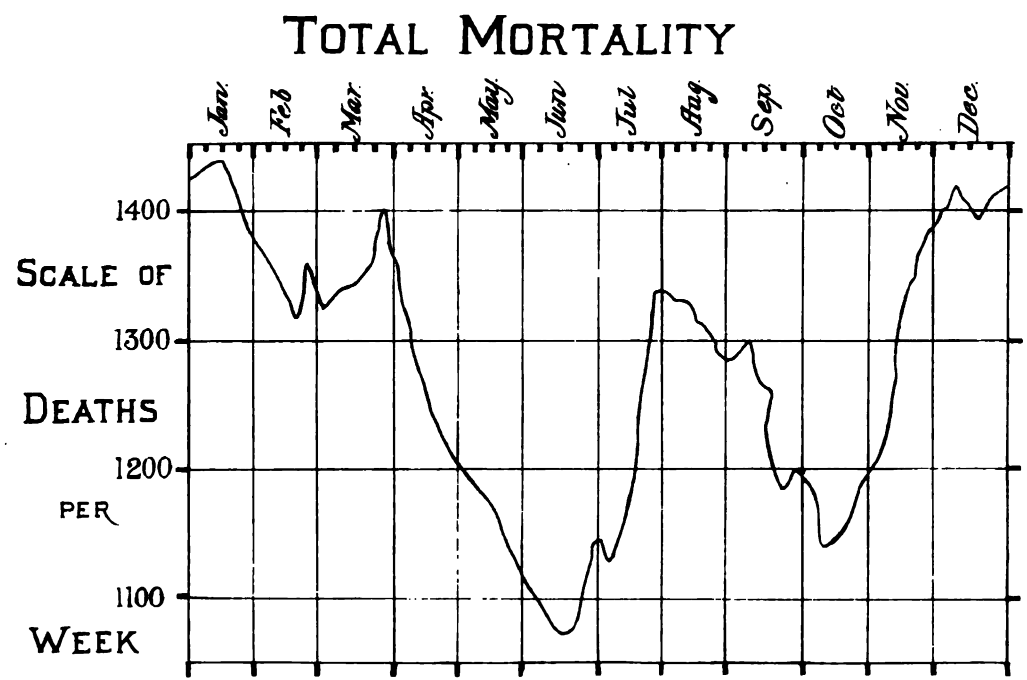
There certainly is not one of the preceding five propositions but is negatived by the common experience of the residents of the United States.

First. The dry air of our driest regions is universally extolled for its healthy, invigorating qualities; and intestinal disorders, if they prevail, are attributed to the drinking water, an l not to the atmosphere.

Second. Rheumatism and bronchial troubles are in the minority in very warm, moist

No I

Fig 1. p 193



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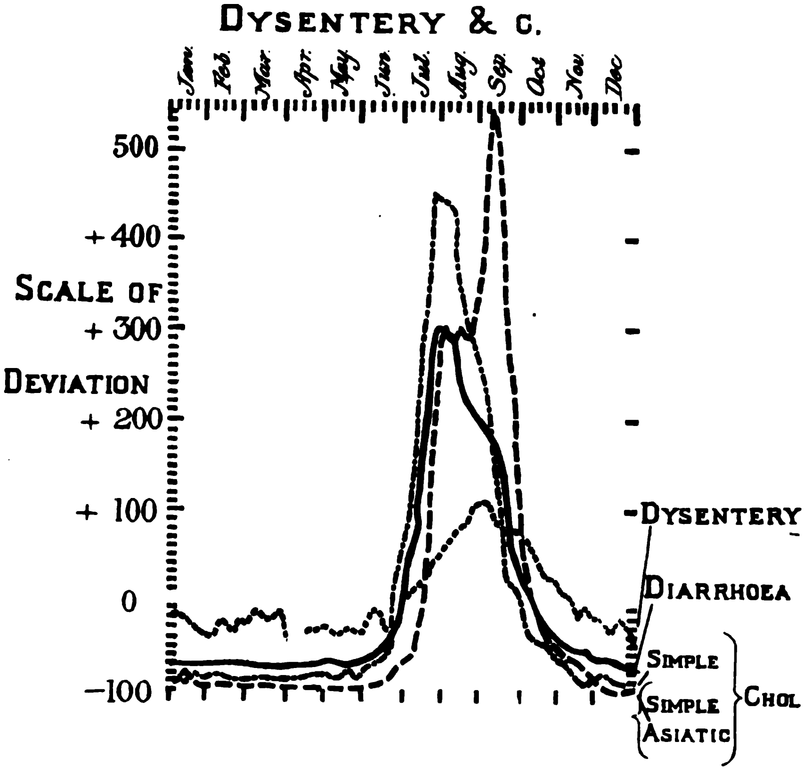
No. II.
Fig 15 p. 189.



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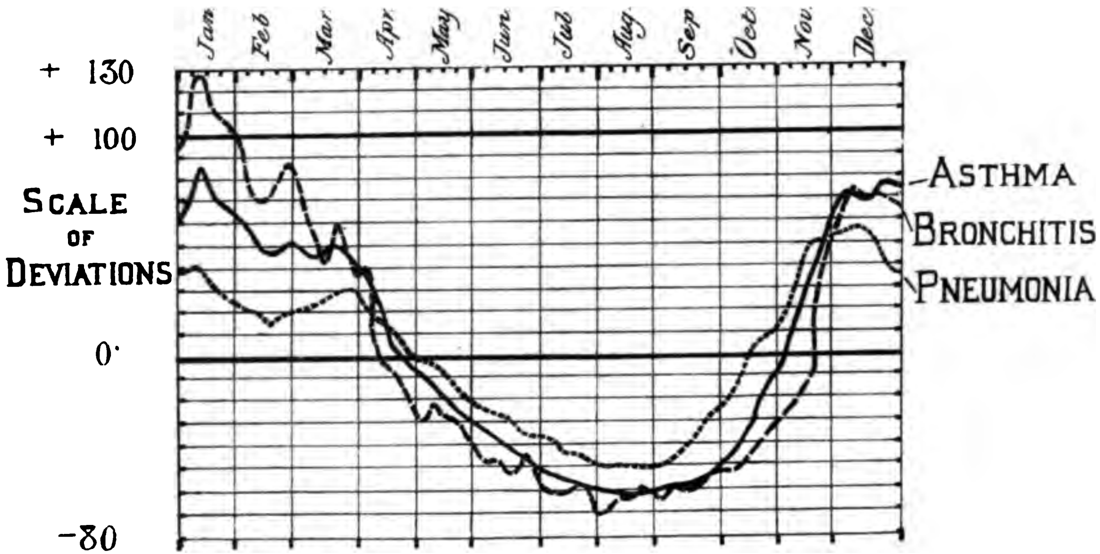
No. III
Fig. 10 p. 210

BRONCHITIS &c



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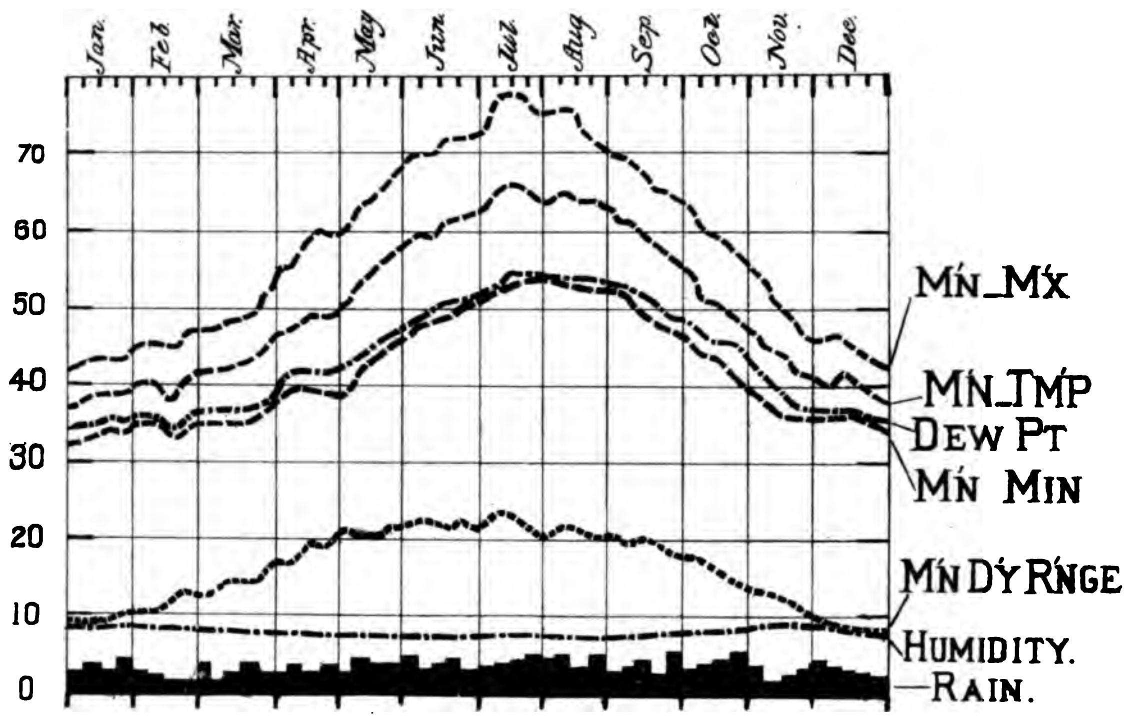
No IV.
Fig. 56 p. 219.

Glimate of London 1845-74



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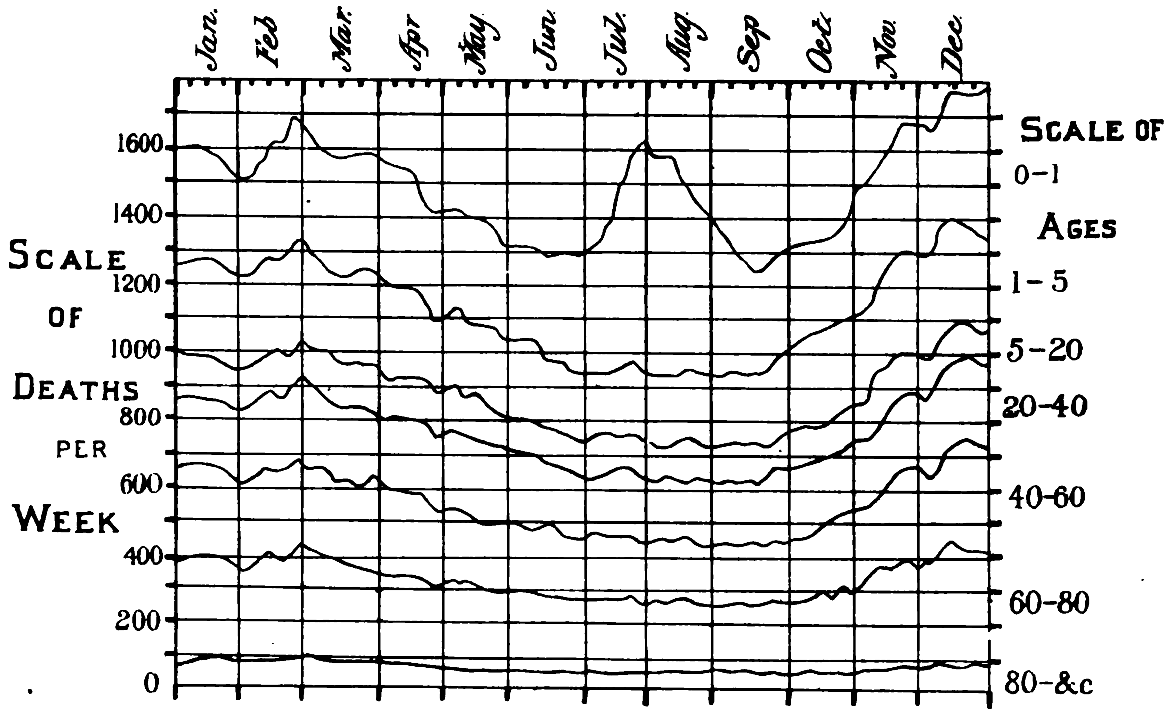
No. V.
Fig. 57 p 228.

TOTAL MORTALITY BY AGES



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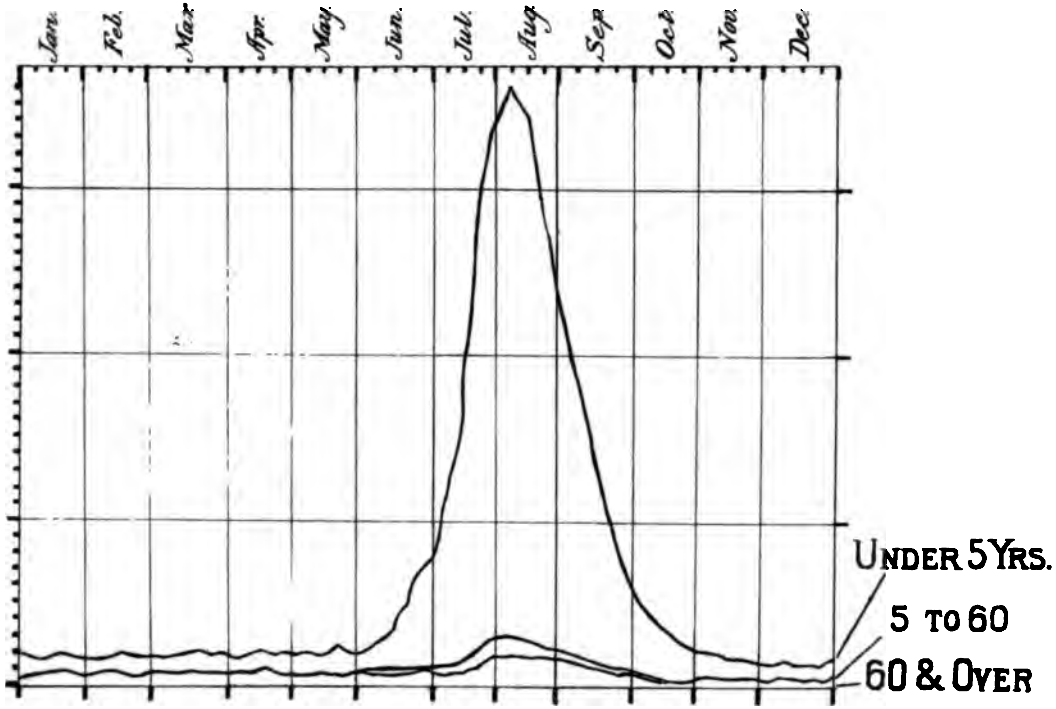
No. VI.
Fig. 58, p. 231.

DIARRHOEA—MORTALITY BY AGES



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climates, such as our own Gulf coast, and if they prevail in New England, are attributed to the sudden daily changes in the weather, and very, very often to heredity.

Third. The dry, cold winter air of Minnesota and Manitoba is borne with impunity and pleasure by every one accustomed to it, and the inflammations of the lungs that occur there have always other and special causes.

Fourth. Humid climates may be and are depressing to those accustomed to a dry climate, but in the natives of Iceland, the Hebrides, Orkneys and Shetlands, Bermudas, Bahamas, and the islands of the Pacific and Indian Oceans, we behold races of men who have not yet been shown to be peculiarly subject to nervous, cutaneous, or pulmonary disorders.

Fifth. The diminution of cholera, diarrhœa, and typhoid fever during rainy seasons, if it be a fact, is more likely to be a secondary effect, due to the more abundant washing and drainage, rather than to any direct influence of rainfall upon the human body; and the diminution is, moreover, largely balanced by the fact that excess of rainfall often operates, by causing overflow of cisterns, to spread the germ of these diseases throughout large masses of otherwise innocuous drinking water.

By these remarks, I would not be misunderstood, but repeat that the average annual temperature, moisture, &c., whatever indirect effects they may have—and these must be conceded by every one—have little or no direct bearing upon the prevalence of any special disease. Perhaps the best proof of this proposition, if it need any, is found by comparing the climates of those regions in which certain diseases are rare, with the records of other regions in which those same diseases are frequent. This I need not do in detail, for the peculiarities of many diseases have come to be so well known that instances will crowd upon your memory to show that neighboring localities, having precisely the same meteorological climate, are in one case exempt, and in the other frequented by given diseases. The fact is, that human beings are capable of becoming acclimated to any uniform condition of the atmosphere, and of living long, healthy lives either on high, dry, sunny plateaus, or on low, damp, foggy seashores; but this vital power of adjustment to our surroundings is very severely tried when at any place we experience *sudden changes* in the atmospheric condition, and it is *then* that the physiological system proves inadequate and becomes disordered.

III. The sudden changes to which I refer are not the gradual and regular annual changes, but they are irregular, or non-periodic changes; and here at once I have to say a few words in reference to another class of very laborious statisticians. Of these, I may take, as a prominent example, the Medico-Climatological Committee of the Scottish Meteorological Society, of which Dr. Arthur Mitchel, of Edinburgh, is the chairman. Dr. Mitchel, with the assistance of Buchan, the well-known meteorologist, has published most elaborate tables, embodying the results of years of labor in studying the weekly mortality returns for London for the thirty years, 1845 to 1874, inclusive. (See The Influence of Weather on Mortality, Jour. Scot. Met. Soc., Feb., 1875, vol. 4, page 185; The Mortality of the large towns of the British Islands, vol. 4, page 307; The Mortality of New York and London Compared, *ibid*, 1878.)

In the first of these papers the authors state "that the primary object of the inquiry is to investigate the seasonal influence of climate on death-rate from different diseases." They accordingly give, both in tabular and in graphic form, the numerical distribution, by weeks throughout the year, of deaths from different diseases, or from special groups of diseases, as also the deaths of old and of young, and of male and of female; they analyze minutely the mortality returns for London, and collate with these, by tables and curves, the mean temperatures, humidity, &c., for thirty years. In the accompanying diagrams, Nos. 1 to 6, I have reproduced some of their results.

You will notice upon these diagrams many remarkable coincidences, all of which have been fully dwelt upon by our authors, and which constitute a very complete description of the parallel courses taken by mortality and climate. But such a descriptive process does not possess any of the characteristics of an investigation into the influence of climate on the death-rate, nor does it give the least positive proof of the actual effect of any such influence. In fact, the authors start with the assumption that there is such an influence; they put the data at hand into perspicuous graphic shape; call attention to some remarkable coincidences, and there suddenly stop, leaving it for others to show that the data prove or disprove the original working hypothesis.

But, inasmuch as our health is affected no more by what the skin feels than by what the stomach drinks and eats, or the lungs breathe, and as these two additional modes of imbibing disease and death also are subject to seasonal changes parallel to the meteorological phenomena, therefore the statistical student must first show us how to separate one influence from the other better than he has hitherto done, if he would succeed in adding to our positive knowledge of the causes of disease and death.

For example, we see conspicuous, the great mortality of children under five years of age culminating the first week in August, and due only to diarrhœa, and about 80 per cent. of which is confined to infants under one year. Now, what proof is offered that this is due to the extreme heat of those weeks in London in face of the other equally

important factors such as acid fruit, unripe fruit, soured milk, tainted milk and food, spore dust in the atmosphere, and other causes, all of which have their culmination and maximum influence, almost exactly simultaneously with each other, and with the temperature? and yet our authors boldly state, on page 230, "it is not cold, but heat which is the great destroyer of the infant life of London." The utter want of logic, the perfect *non sequitur* of this conclusion is but little ameliorated by the fact that on the next page the authors do allow that the influence of food and nursing needs to be investigated.

The fallacy of such conclusions is revealed at once if we supply the omitted premise, and the reasoning would stand thus:

Diarrhœa prevails in hot weather.

Every other conceivable cause has been examined and proven to be harmless.

Therefore heat causes diarrhœa.

Certainly no one will be found to maintain the truth of the premise that we have here had to supply.

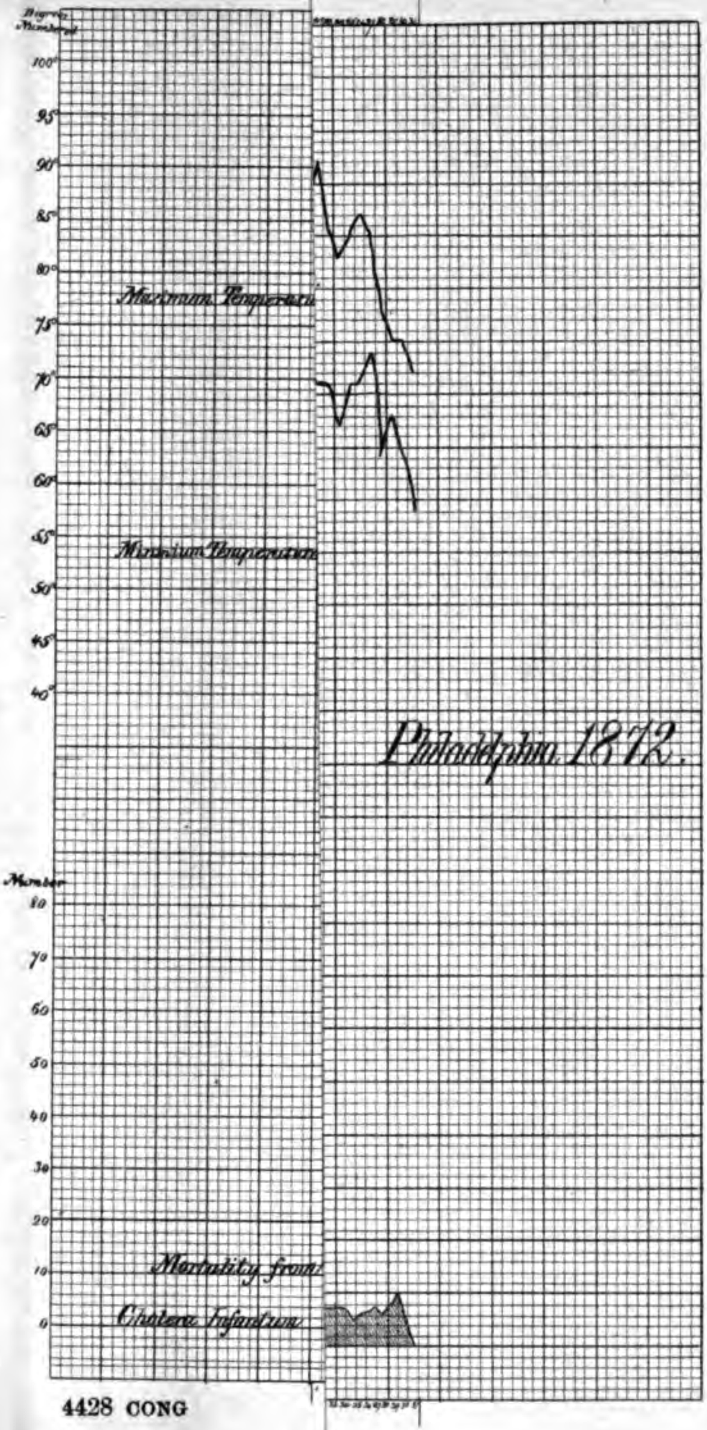
More guarded is the similar remark, on page 50, of the report for 1872 of the board of health of Philadelphia, where, under the heading of "Causes of death from cholera infantum," we read as follows: "In the development of cholera infantum a high degree of temperature and excessive humidity act as powerful predisposing causes." But when the authors add, "We are not at a loss in assigning the reason for the exceptional increase in the death-rate of this disease, when we consult the meteorological observations for the year," we cannot but wish that they would more clearly show us whether the oppressive heat does not affect the mother and the child's food far more than it does the babe directly. They probably meant to say that the CHANGE FROM SPRING TO OPPRESSIVE SUMMER WEATHER, which was remarkably severe in 1872, induces the predisposition to diarrhœa, but even in this shape we see no reason to accept the statement as logical conclusion. In fact, I dare to say that the meteorological statistics prove clearly that great mortality from *cholera infantum* does not always or necessarily prevail in hot weather, so that the conclusion that heat causes diarrhœa absolutely loses both of its supporting premises and falls flat to the ground.

For instance, examine the unprecedented mortality from cholera infantum, as given in the Philadelphia report for 1872, and as reproduced in the accompanying diagram, No. 7. This diagram shows also the curves of the daily maximum and minimum temperatures for the Washington Naval Observatory, which will not differ greatly from the curves for Philadelphia, for which I have not the necessary data at hand at the moment of writing. The first feature that strikes the student is the maximum mortality of July 6 and 13. Next comes the fact that the equally hot or hotter periods in May 6–12, June 6–14, August 7–15, and 17–27 and September 6–10, were not attended by any special increase, but rather a very decided decrease or absence of cholera infantum, whence we can infallibly conclude that high temperature has, in itself, very little direct influence on the disease, and this becomes clearer when we reflect that the actual mortality occurs always some time after the disease has taken hold upon the child, and that the maximum mortality of July 6 occurred two weeks after the remarkable sudden fall of temperature that is shown to have occurred on June 22 and 24. I must maintain, therefore, that it is a perfectly plausible hypothesis that the sudden change from hot to cold on that date was the cause of many infants or their mothers taking cold, which settled in the bowels, and that the disease ran along with no more than the ordinary mortality, until the sudden increase of heat on July 6 caused the mothers to yield to the temptation of a change of diet from one of animal food and ripe vegetables to one of fresh vegetables and fruit, a change that assuredly always affects the babe far more than the direct influence of the temperature. Why will not some one compare the statistics of cholera infantum with the daily sales of cherries, cucumbers, green apples, &c.? I predict some very important coincidences will be revealed.

I may remark that the diagram here given shows also the minimum temperature of each day, but as the babe is usually well protected against the cold of early morning, and is exposed to the free air only during the warmer part of the day, it is evidently proper for us, in this case, to confine our attention to a comparison of the curve of mortality with that of maximum temperature.

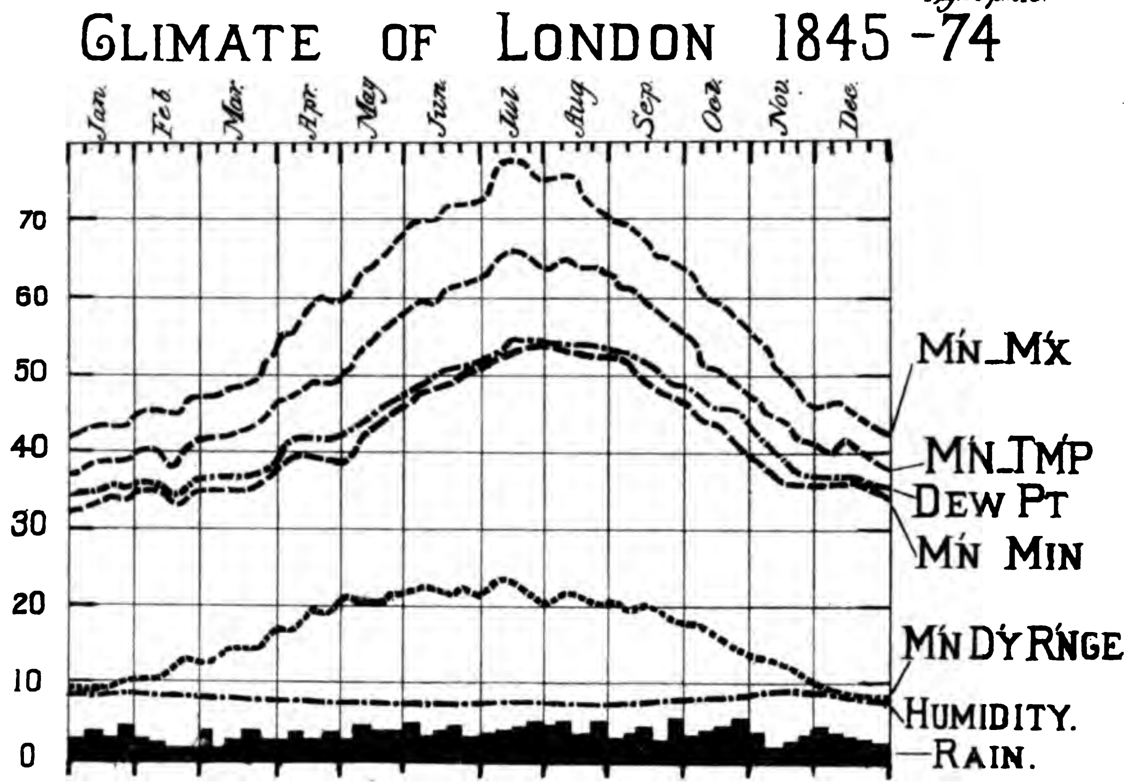
IV. I therefore repeat the conclusion previously given in this paper, that these masses of statistics do not prove that the average annual temperature, or the regular seasonal variations from midwinter to midsummer, have any direct effect on human health, but only show that there is for each disease a systematic periodicity; the causes of this periodicity, as it seems to me, can never be revealed by any such simple statistical processes. And yet it is the cause and the remedy that is the great object of our search, and we meet to consider the question how far the results of statistical comparison between weather and disease justify further labor in that line, or whether they point towards other lines of research.

On this question I will not long detain you with reasonings, but will directly express my own convictions in the following sentence: The students of climatological



Maximum Temperature
Minimum Temperature
Philadelphia 1872.
Mortality from
Cholera Infantum

No. IV.
Fig. 56 p. 219.



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No. V.
Fig. 57 p 228

TOTAL MORTALITY BY AGES

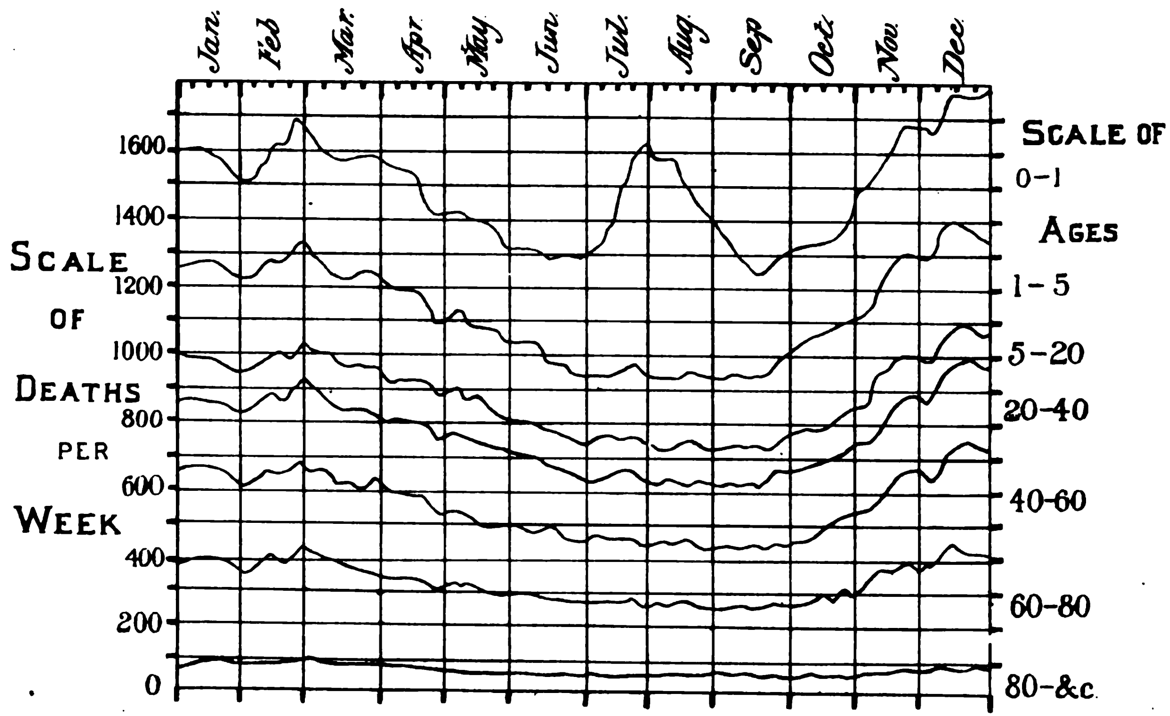

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Table showing street numbers, uses, population, and connection or non-connection of buildings with the Pine street sewer, Providence, R. I., October 6, 1879.

Street number.	Number of families in house.	Number of persons in house.	Uses of building.	Population in houses connected with sewer.	Population in houses not connected with sewer.	Remarks.
218	2	10	Residence	10	......	
222	......	1	Grocery	......	1	
226	Vacant.	Vacant.	Residence	......	......	Vacant; connected with sewer.
240	2	7	......do	......	7	
242	2	6	......do	6	......	
	4	10	......do	......	10	House not numbered.
258	2	7	......do	......	7	
262	2	6	......do	......	6	
266	2	8	......do	8	......	
270	1	9	......do	9	......	
276	Vacant.	Vacant.	......do	......	......	Vacant; connected with sewer.
280	2	7	......do	7	......	
282	1	5	......do	5	......	
288	1	2	......do	2	......	
290	‡1	10	Boarding-house	10	......	Washing of seven persons not done here.
298	2	6	Residence	......	6	
300	1	7	......do	7	......	
304	1	3	......do	3	......	
306	‡1	8	Boarding-house	8	......	Washing of five persons not done here.
310	2	5	Residence	5	......	
322	2	10	......do	10	......	
328	1	4	......do	......	4	
332	2	9	......do	9	......	
336	1	5	......do	......	5	
340	2	11	......do	......	11	
346	1	6	......do	6	......	
33	4	10	......do	10	......	No. 33 Chestnut; not numbered on Pine.
221	1	2	......do	......	2	
225	2	7	......do	7	......	
229	2	12	......do	......	12	
235	2	5	......do	5	......	
	2	7	......do	7	......	No. 17 Gould Lane.
239	2	6	......do	6	......	
247	1	5	......do	......	5	
253	2	8	......do	8	......	
	2	6	......do	6	......	No. 20 Claverick street.
261	2	8	......do	8	......	
265	2	9	......do	......	9	
271*	......	......	......do	......	......	Not connected.
275	2	8	......do	8	......	
279	2	8	......do	8	......	
281	2	7	......do	7	......	
285	1	7	......do	7	......	
289	2	6	......do	6	......	
301†	2	11	......do	11	......	
305	......	1	Shoe-shop	......	1	
309	1	8	House and meat-shop	8	......	
311	1	7	House and barber-shop	......	7	
317	2	6	House and laundry	......	6	
319	1	3	Residence	3	......	
321	2	7	......do	7	......	
325	Vacant.	Vacant.	Stores	......	......	Vacant; connected with sewer.
327	2	4	Residence	4	......	
	2	10	......do	10	......	Back of 327; no number.
329	1	6	......do	6	......	
333	1	4	......do	4	......	
337	1	10	......do	10	......	
339	2	6	......do	6	......	
Total	89	366		267	99	

* No answer to bell.
† Soap factory in rear; connected, but not discharging October 8, 1879.
‡ And others.

Total number of buildings possibly tributary to the Pine-street sewer 60
Total number of buildings actually tributary to the Pine-street sewer, October 6, 1879 41

Diameters of sewers capable of discharging 50 gallons per front foot, or 1,250 gallons per house (25 front feet), per day, when running three-fourths full.

Number of front feet.	Fall of sewer per 100 feet. .2	.4	.6	.8	1.0	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	Number of houses.
	Diameter in feet.																	
100	.124	.108	.100	.094	.090	.086	.083	.081	.078	.077	.075	.074	.072	.071	.070	.069	.068	4
200	.164	.143	.132	.124	.119	.114	.110	.106	.103	.101	.099	.097	.095	.094	.093	.091	.090	8
300	.193	.168	.135	.146	.140	.134	.129	.125	.122	.119	.116	.114	.112	.110	.109	.107	.106	12
400	.216	.188	.174	.164	.157	.150	.145	.140	.137	.133	.131	.128	.126	.124	.122	.120	.119	16
500	.237	.206	.190	.179	.172	.164	.158	.153	.149	.146	.143	.140	.138	.135	.133	.132	.130	20
600	.255	.222	.204	.193	.184	.176	.170	.165	.161	.157	.154	.151	.148	.146	.144	.142	.140	24
700	.271	.236	.217	.205	.196	.188	.181	.175	.171	.167	.163	.160	.158	.155	.153	.151	.149	28
800	.286	.247	.229	.216	.207	.197	.191	.185	.180	.176	.172	.169	.166	.164	.161	.159	.157	32
900	.299	.261	.240	.227	.217	.207	.200	.194	.189	.184	.181	.177	.174	.171	.169	.167	.164	36
1,000	.312	.272	.251	.237	.226	.216	.209	.202	.197	.192	.188	.185	.182	.179	.176	.174	.171	40
2,000	.412	.359	.331	.312	.299	.286	.275	.267	.200	.254	.249	.244	.240	.236	.232	.229	.226	80
3,000	.485	.423	.389	.367	.351	.336	.324	.314	.306	.299	.292	.287	.282	.277	.273	.270	.266	120
4,000	.544	.473	.437	.412	.392	.377	.363	.352	.343	.335	.328	.322	.316	.311	.307	.302	.299	160
5,000	.594	.522	.477	.450	.431	.412	.397	.385	.375	.366	.359	.352	.346	.340	.335	.331	.326	200
6,000	.630	.557	.513	.485	.463	.443	.427	.414	.403	.394	.386	.378	.372	.366	.361	.356	.351	240
7,000	.680	.592	.546	.515	.493	.471	.454	.441	.429	.419	.410	.403	.396	.389	.384	.378	.374	280
8,000	.717	.624	.576	.544	.520	.497	.479	.465	.453	.442	.433	.425	.417	.411	.405	.399	.394	320
9,000	.752	.655	.604	.570	.545	.521	.503	.487	.474	.463	.464	.445	.437	.431	.424	.418	.413	360
10,000	.784	.683	.630	.594	.568	.544	.524	.508	.495	.483	.473	.464	.456	.449	.442	.436	.431	400
20,000	1.035	.901	.831	.784	.750	.717	.692	.671	.653	.638	.624	.618	.602	.593	.584	.576	.568	800
30,000	1.217	1.060	.977	.922	.883	.844	.813	.789	.768	.750	.734	.721	.708	.697	.687	.677	.668	1,200
40,000	1.365	1.119	1.096	1.035	.990	.946	.913	.885	.862	.841	.824	.808	.794	.782	.770	.760	.750	1,600
50,000	1.493	1.312	1.198	1.131	1.082	1.035	.998	.967	.942	.920	.901	.884	.869	.855	.842	.831	.820	2,000
60,000	1.606	1.398	1.289	1.217	1.164	1.113	1.073	1.041	1.013	.990	.969	.951	.934	.919	.906	.894	.882	2,400
70,000	1.708	1.487	1.371	1.294	1.238	1.184	1.142	1.107	1.078	1.053	1.031	1.011	.994	.978	.964	.950	.938	2,800
80,000	1.802	1.569	1.446	1.306	1.306	1.249	1.204	1.168	1.137	1.110	1.087	1.067	1.048	1.032	1.017	1.003	.990	3,200
90,000	1.889	1.644	1.516	1.431	1.366	1.309	1.262	1.224	1.192	1.164	1.140	1.118	1.099	1.081	1.066	1.051	1.037	3,600
100,000	1.970	1.715	1.581	1.493	1.428	1.366	1.317	1.277	1.243	1.214	1.189	1.166	1.146	1.128	1.111	1.096	1.082	4,000

FORMULA.

$$d=\left(\frac{n^2}{h}\times \log.^{-1}\,0.7732933-10\right)^{\frac{3}{8}}=\frac{1}{6}\left(\frac{n^2}{h}\right)^{\frac{3}{8}}$$ d = diameter in feet, n = number of front feet, h = fall per 100 feet.

SAINT LOUIS, *April* 8, 1880.

ROBT. MOORE,
Sewer Commissioner.

APPENDIX G.

REPORT UPON THE EFFECT OF INOCULATING THE LOWER ANIMALS WITH DIPHTHERITIC EXUDATION.

By Drs. H. C. Wood and Henry F. Formad.

The object of the research which we have the honor to report to your board was to determine whether it is possible to produce diphtheria in the lower animals by the inoculation of the exudations from diseased human subjects. The experimental results and theories promulgated by Oertel, Trendelenburg, and others are so well known that we shall give no detailed references to them, but confine ourselves to our own experimental researches and the discussion of essential facts. There can be no doubt that animals not rarely die of pseudo-membranous affections offering symptoms similar to those of diphtheria in man. An epidemic of such disorder amongst rabbits will be spoken of later from our own experience. It is, however, by no means certain that these pseudo-membranous affections in the lower animals are the same as the human disorder. In attempting the systematic investigation of the subject our first series of experiments were made to determine the effects of inoculating animals with membrane taken from persons sick with diphtheria. The poison was put in little pockets made with a lancet under the skin, or inoculated by scarification in the mucous membrane of the mouth; in many instances both methods were simultaneously practiced; unless otherwise stated, no antiseptics had been used on throat near the time of taking away the membrane.

There are recorded in the table first given thirty-two experiments, in only six of which the animals died, unless killed accidentally or otherwise. The time between the dates of death and of the last inoculation was, Experiment IV, six days; Experiment VI, seventy hours; Experiment XI, fifteen days; Experiment XVI, eleven days; Experiment XXIII, thirteen days; Experiment XXV, two days. The question naturally arises as to whether the few animals in which the inoculation was followed by death died of diphtheria or of some other disease. There is only one sign which can be considered pathognomonic of the diphtheritic process, namely, the formation of false membrane in various parts of the body; and it is to be noted that only in one case were there any exudations present in any organ which could give rise to the slightest suspicion that the animal died from diphtheria. In this case, Experiment XVI, there was only an indication of exudation upon the trachea, which, while it may have been due simply to a catarrhal inflammation, presents some of the characteristics of false membrane. A microscopic specimen of this, Experiment A, page 385.

It has been asserted by Oertel that animals which have been inoculated with diphtheritic material die with their internal organs infested with micrococci, and that the presence of these is characteristic of diphtheria. We have carefully examined the internal organs of the rabbits which died, as well as the blood of those which survived, and found no micrococci. In this our results are in complete accord with the very careful labors of Curtis and Satterthwaite.

The utmost care is necessary to prevent the entrance into the blood of bacteria, from without. Thus, we have cut the jugular vein of a rabbit and, examining the blood at once, found it entirely free from bacteria. When, however, after the lapse of a few minutes the post mortem was concluded and the heart opened, the blood therein contained possessed an abundance of these low organisms.

It will hereafter be shown that micrococci indistinguishable from those of diphtheria are abundant in the false membrane produced traumatically in the trachea of rabbits, and we therefore conclude that these organisms are at least not characteristic of diphtheria. If they be so, however, we must conclude that none of the animals which we inoculated took the disease, since no bacteria or micrococci were present except in the lungs, upon whose surface they may often be met with in animals which certainly have not been infected with diphtheria.

If our animals did not die of diphtheria, of what did they die? A study of the post-mortem reports will show that in every case the internal organs were tubercular, and in many cases intensely so; also, that tubercular disease was found in the organs of rabbits which were killed some days after inoculation. It is therefore a very natural belief that in those cases in which death was long delayed it was due to tuberculosis. It certainly is very possible that when death takes place soon after inoculation it may be the result of a non-specific blood poisoning, and not of diphtheria. In the experiments of Curtis and Satterthwaite, death not rarely occurred in a very brief time; with us it was almost always very long delayed. The difference may have been from

our using smaller portions of the diphtheritic material and inoculating less deeply than did those gentlemen. It is, perhaps, proper to call attention to the fact that in no case did inoculation in the mouth produce either local or general symptoms.

In order to discover whether the diphtheritic exudation acted specifically in the production of tubercle, or whether it merely set up a local inflammation which formed a focus of infection, we experimented by putting under the skin of rabbits small masses of innocuous foreign matters.

It will be seen that in five out of nine of these experiments tubercle was found after death; this large proportion apparently demonstrates that a simple local inflammation may in the rabbit act as a source of tubercular infection. Now, in our experiments, as in those of Drs. Curtis and Satterthwaite, where diptheritic matter was inoculated, inflammation was almost always induced at the seat of the lesion, with the formation of large lumps containing cheesy matter. These facts being so, it is a fair deduction that the tubercles were secondary to these inflammatory foci, and were therefore an indirect and not a direct result of the inoculation. We believe, therefore, that diphtheritic membrane placed under the skin or in the muscles of rabbits may cause death in a few hours by the production of a blood poisoning, which is not accompanied by any specific symptoms or lesions, or, after many days, by the development of a secondary tuberculosis.

The method by which Trendelenburg asserts that he succeeded in producing diphtheria in rabbits consists in placing the exudation matter in the trachea. As our experiments have led us to attach no importance to micrococci as a test of diphtheria, we naturally have suspected that the membrane when placed in the trachea produces simply a trachitis. This suspicion has been strengthened by the observation that acute pseudo-membranous trachitis and angina seem to occur in rabbits. Such an epidemic destroyed during the last winter a number of rabbits kept by one of us in a perfectly clean place. The rabbits first showed sickness by refusing food; examination then detected swelling of the tonsils with exudation upon them. There was high fever with increase of the local symtoms until the animals became entirely unable to swallow. Death occurred in from three to seven days, preceded by great difficulty of breathing and profound exhaustion. False membrane was abundant in the mouth and trachea. It showed on examination all the characteristics of diphtheria exudation. If it meets the approbation of the National Board, we would like during the coming winter to determine experimentally whether it is not possible to produce at will such diphtheria-like epidemics; and also how far contagion has to do with the spread of the disorder.

The next series of experiments were undertaken to determine the correctness of the assertion of Trendelenburg that the introduction of pseudo-membrane into the trachea produces diphtheria. Unfortunately, owing to the coming on of warm weather, we have been unable to obtain a sufficient supply of exudation to test the subject fully, but it will be seen that in one of the four experiments made with dried exudation pseudo-membranous trachitis was produced. So that Trendelenburg's assertions, which have also been confirmed by Oertel, seem to be correct. But we do not feel that our experiments have as yet been sufficient to enable us to speak positively from personal knowledge.

As stated by Professor Oertel and other observers, the injection of certain corrosives will produce in the rabbit pseudo-membranous trachitis.

Our next series of experiments were performed to determine whether such production is possible in other animals than the rabbit, and also whether the membrane thus obtained resembles that occurring spontaneously or produced by the introduction of diphtheritic matter into the trachea.

The experiments which are recorded in the last table show that ammonia is able to produce in the cat and dog, as well as in the rabbit, a pseudo-membranous trachitis. Professor Oertel states that the membrane produced by cauterization of the trachea differs from diphtheritic membrane in containing no bacteria. What has led him to such an assertion, we cannot comprehend. When the death occurred very quickly bacteria and micrococci may have been less abundant in the traumatic membrane than in that taken from the throat of patients, but when the animal survived some days and the bacteria had sufficient time to develop themselves—when, in other words, they were afforded as good opportunity of growth as in the natural disease—they were immensely abundant, in some cases seeming to make up a large part of the bulk of the membrane.

If it be possible to produce a fatal pseudo-membranous trachitis by placing the diptheritic membrane in the trachea, and not possible to cause septicæmia by inoculating other portions of the body with the same material, it would appear as though diphtheria might be originally a local disease with a subsequent septic poisoning. The scope for investigation here opened is very great; on account of the lack of time, we have not attempted, at present, to answer fully the questions which arise; we have, however, performed a number of experiments to determine whether any products of disease other than diptheritic exudations are capable of causing pseudo-membranous trachitis.

FIRST SERIES OF EXPERIMENTS.

Inoculation of diphtheritic matter subcutaneously and in the mucous membrane of the mouth.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of post mortem, and of microscopic examination.	Remarks chiefly upon source of matter employed.
1	Apr. 22	Small rabbit, No. 1.	Inoculated on tongue with fresh diphtheritic membrane.	Remained perfectly well to May 16, 24 days, when they were accidentally killed.	No signs of diphtheritic inflammation anywhere. The spleen, lymph, glands, liver, and lung showed some tubercle granulations. The rest of the organs normal. No bacteria in the organs.	Case I.—Material taken by Dr. Cardeza from child, 3 hours previously to inoculation. Child's throat had been touched with tincture of iron and glycerine previously.
2	Apr. 22	Small rabbit, No. 2.	Same as last			
3	Apr. 24	Small rabbit, No. 3.	Same as last	Remained well		Same case. The throat for 24 hours previous to the removal had not been touched by anything.
4	Apr. 24	Small rabbit, No. 4.	Same as last	Died May 10	No lesions except lymphatic glands swollen and tuberculous; also spleen. No bacteria in organs.	Same case and exudation as last.
5	Apr. 24	Large gray rabbit, No. 5.	Inoculated in mouth; had also a piece of membrane put under the skin of the side.	May 4, was feverish for several days; a hard lump developed on the side at the seat of inoculation consisting of cheesy matter. June 6, animal well, cheesy lump smaller but persistent. Animal remained well.	Cheesy matter composed of pus, compound granule cells, debris, and numerous bacteria.	Same case. The child recovered from the acute attack, which was followed by paralysis, finally resulting in death.
6	Apr. 29	Small albino rabbit, No. 6.	Inoculated with fresh diphtheritic membrane in mouth, tongue, roof, and pharynx, and also subcutaneously on thigh.	Died May 2, 70 hours after inoculation, in convulsions, which commenced 6 hours previous to death.	Small cheesy lump at the seat of subcutaneous inoculation. Tongue ulcerated; no signs of diphtheritic inflammation anywhere; all organs hyperæmic, otherwise of normal appearance, but upon microscopic examination tubercular granulations well marked in lung, liver, spleen, and lymphatic glands. No bacteria in organs except lungs, where are also hemorrhagic infarctions.	Case II.—Removed by Dr. Dunmire from the throat of child a few hours previously.
7	Apr. 29	Small albino rabbit, No. 7.	Same as last	Animal remained well		Same case.

8	Apr. 29	Small rabbit, No. 8	Same as last	Remained well to May 1, when killed accidentally.	Post mortem revealed no lesions.	Case III.—From Dr. Cardesa; inoculation made 15 minutes after removal of the membrane from the child's throat. This case was in same family as No. 1, and originally apparently contagious.
9	Apr. 29	Small rabbit, No. 9	Same as last	Remained well to May 16, when accidentally killed.		
10	Apr. 29	Albino rabbit, middle-sized, No. 10.	Same as last	Remained well.		
11	Apr. 30	Rabbit, No. 3	Re-inoculated with diphtheritic matter in mouth and subcutaneously. May 7, inoculated third time.	Remained well up to May 13; found dead May 14.	Small cheesy lump on thigh at the place of inoculation. All organs tubercular, otherwise to the naked eye of normal appearance. No bacteria in organs.	Case IV.—From Dr. James Collins, twelfth day of disease. Matter semi-liquid, mixed with blood. The case afterward died.
12	Apr. 30	Dog, No. 1	Inoculated with diphtheritic membrane in mouth and thigh.	Remained well		Same case.
13	Apr. 30	Large cat, No. 1	Inoculated with diphtheritic matter in mouth and subcutaneously on right thigh.	Remained well; a large lump developed in skin at seat of inoculation, which eventually disappeared. No micrococci in blood.		Case IV.—From Dr. Collins. Case recovered.
14	Apr. 30	Rabbit, No. 11, large albino.	Same as last.			
15	Apr. 30	Rabbit, No. 12, large old albino.	Same as last	Remained well.		
16	May 1	Small rabbit, No. 13.	Same as last	A small cheesy lump developed at seat of inoculation; died May 12.	Slight exudation on the mucous membrane of the larynx and trachea, of grayish color and translucent. Trachea and lungs much congested. All organs tubercular; in the lungs are seen profuse hemorrhagic infarctions, and numerous bacteria. No bacteria in the organs.	Case V.—From Dr. W. S. Stewart. Membrane inoculated fresh on the day of removal.
17	May 1	Large cat, No. 2	Same as former	Remained well; lump developed on side and disappeared within a week, healing perfectly. No micrococci in blood.		Same case.
18	May 1	Small cat, No. 3	Inoculated in mouth	Remained well		Same case.
19	May 1	Dog, No. 2	Inoculated in mouth, pharynx, tonsils, tongue, and also subcutaneously on the side, with fresh diptheritic matter. The latter also given to the animal mixed with food.	Remained well. Killed June 11.	Cheesy lump which had existed for a long while on the side found to have been absorbed; in its place found a hard lump, probably of cicatricial tissue. No lesions perceptible. Blood examined during life did not show any bacteria.	
20	May 4	Small cat, No. 4	Inoculated with dried diphtheritic matter in mouth and subcutaneously.	Remained well. Killed June 12.	No lesions found; blood did not contain bacteria.	Case VI.—From Dr. Frank R. Brunner. Membrane removed several days ago from woman of 45 years; apparently much decomposed.

FIRST SERIES OF EXPERIMENTS.

Inoculation of diptheritic matter, &c.—Continued.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
21	May 4	Large rabbit, No. 14.	Same as in last experimemt	Remained well. Has large lump at place of skin inoculation.	No lesions except a large cheesy lump on side. No microscopic examination made.	
22	May 4	Cat, No. 5	Same as last	Remained well. Killed June 12.	Large cheesy lump at the place of subcutaneous inoculation; no signs of diphtheritic inflammation; lungs highly congested, the remaining organs all appearing normal to the naked eye; but microscopic examination showed tubercular granulations everywhere; hemorrhagic infarctions in lungs; no bacteria in organs except lungs.	Case VII.—From Dr. Collins.
23	May 7	Large rabbit, No. 15.	Same as last	Remained well up to May 19. Found dead May 20.		
24	May 7	Small rabbit, No. 9	Reinoculated with fresh diphtheritic matter in mouth and subcutaneously.	Killed accidentally	Post mortem revealed no lesion	See experiment 9.
25	May 7	Small rabbit, No. 3	Inoculated the third time as before with fresh matter.	Died May 9	A small cheesy lump on thigh at the place of inoculation; all organs tubercular, otherwise to the naked eye of normal appearance; no bacteria in organs.	
26	May 9	Dog, No. 3	Inoculated in mouth and skin with fresh membrane.	Remained well		Case VIII.—From Dr. James Collins.
27	May 9	Small cat, No. 6.	Same as the last	Remained well. Killed June 12	All had cicatrizing lump at place of skin inoculation; no other lesions detected; no bacteria in blood.	From Dr. James Collins.
28	May 9	Small cat, No. 7.				
29	May 9	Small cat, No. 8.				
30	May 11	Goat, No. 1	Inoculated in mouth and subcutaneously with fresh membrane.	Remained well		Case IX.—From Dr. H. C. Wood. Taken from a case the second day of the disease, the attack having been derived by contagion from the cases of Dr. Cardeza.
31	May 11	Cat, No. 9	Similar inoculation	Remained well.		
32	May 11	Cat, No. 10	Same as before	Found dead June 11	No microscopic examination made; specimen preserved.	

SECOND SERIES OF EXPERIMENTS.

Inoculation of foreign bodies subcutaneously.

33	Apr. 19	Small rabbit, No. 16.	A piece of wood, fragment of a match, put below the skin in the posterior part of the neck and the wound closed by a suture.	Wound healed rapidly, but subsequently a small lump of cheesy matter was formed. The animal was feverish for several days. In the lapse of two weeks the lump disappeared, and the animal remained well to date, June 8.	....	The foreign bodies used here have been before the experiments thoroughly washed and cleaned.
34	Apr. 22	Small albino rabbit, No. 17.	Treated similarly	Wound healed rapidly, but within a few days a large lump formed; ulceration set in, and cheesy matter protruded from wound; animal became emaciated, feverish. Died May 13.	All organs appeared hyperæmic; liver contains several small abscesses and numerous small nodules, the latter also seen in lung and spleen; lymphatic glands swollen; microscopic examination revealed large collections of tubercle granulations in all organs; the proportion of white blood corpuscle increased; no bacteria in blood.	
35	Apr. 22	Small rabbit, No. 18.	A piece of clean glass put below the skin in the right thigh; wound closed.	Result similar to last, only slower. Died May 20.	Lesions similar to the last, but slighter in degree; hemorrhagic infarctions in lungs very marked.	
36	Apr. 25	Large albino rabbit, No. 19.	A piece of glass put deep below the skin in the right thigh; wound closed.	Wound healed at first, then severe ulceration set in, cheesy matter protruding from wound; the latter increased to four times the original size. Died May 10.	No decided lesions to the naked eye; microscopic examination showed all organs to be profusely tubercular; hemorrhagic infarctions in the lungs; echinococci cysts in the liver; no bacteria in the organs.	
37	Apr. 25	Albino rabbit, No. 20.	Treated similarly	} Wound healed after slight suppuration. Animals remain well.		
38	Apr. 25	Small rabbit, No. 21.	Treated similarily with a piece of cork.			
39	Apr. 25	Small rabbit, No. 22.	Treated similarly with a small bunch of clean hair.			
40	May 6	Small rabbit, No. 23.	A piece of wood, fragment of a match, put deep below the skin in the right thigh.	Cheesy lump formed rapidly and protruded from wound. Died May 19.	All organs showed masses of tubercle granulations; no other decided lesions; no bacteria in the organs.	
41	May 6	Small rabbit, No. 24.	A piece of wire put below skin in the left thigh.	Cheesy lump formed; the wire ulcerated away. Died May 15.	Hemorrhagic infarctions in lungs; tubercle granulations everywhere, although not very marked; no bacteria in the organs; none in the blood.	

THIRD SERIES OF EXPERIMENTS.

Inoculation with diphtheretic matter in the trachea.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
42	May 31.	Large albino rabbit, No. 27. Fresh rabbit.	Inoculated with dried diphtheritic matter, mixed with water, in the trachea, from without.	Still alive and well, June 20		Case X.—Of diptheria, received through Dr. Jaggard, about 24 hours after removal. The membrane dry and hard; apparently in perfect condition.
43	June 1.	Albino rabbit, No. 10. See experiment 10.	Same as last	Died June 6, five days after inoculation, in convulsions.	External wound had healed perfectly; some ecchymosis noticeable, and the subcutaneous tissue infiltrated and congested. The wound in the trachea did not quite heal; larynx and trachea are congested and covered by a delicate true pseudo-membrane, which reaches, near the larynx, a thickness of 1mm. Microscopically, it also appears fully identical with the natural and with the ammonia false membrane, containing micrococci in large number. No bacteria in blood, none in organs. The organs are tubercular, more especially the liver, where large nodules can be seen even by the naked eye. No hyperæmia of organs, as in the ammonia specimen.	Same case.
44	June 14.	Young albino rabbit, No. 37.	Inoculated with dried diphtheritic matter, mixed with water, in the trachea.	June 18. Evening. Animals apparently well; take food, &c.; breathing not much interfered with. The same evening killed rabbit 37; No. 38 was found dead June 19.	No lesions; no bacteria in blood, which was very carefully examined.	Case II.—Diphtheritic matter taken by Dr. Richard A. Cleeman from throat of patient untouched; inoculation about 36 hours after membrane was taken; it was dried quickly and was in good condition.
45	June 14.	Young albino rabbit, No. 38.	Same as last		No lesion; blood not examined.	Same as last.

FOURTH SERIES OF EXPERIMENTS.

Injection of ammonia into the trachea.

46	May 15, 4 p. m.	Large albino rabbit, No. 11.	Injected three or four drops of aqua ammonia into the trachea from without, the trachea being laid bare and a small opening cut into it.	Died May 18, 1 p. m., in convulsions, 69 hours after inoculation. During sickness breathing of the animal was extremely affected, very forced, deep, the rabbit opening the mouth widely at each straining effort, and raising the head; did not take food except the last twelve hours before death, when he seemed to feel easier.	Wound in skin and muscles covering the trachea was suppurating; tracheal wound had healed. All organs strongly hyperæmic, and tubercular nodules recognizable by naked eye. On opening the larynx and trachea, a well-developed pseudo-membrane of 1 to 3 mm. in thickness was seen, which reached below the bifurcation and into the smaller bronchio. It resembles fully in color, consistency, and easiness of detachment, the natural croupous membrane, and is perfectly identical with the latter upon microscopic examination. Bacteria are abundant, both in spheres and disseminated; none in internal organs except the lungs. Tubercles most prominent in the lungs, spleen, and lymphatic glands. Hemorrhagic infarction in lungs.
47	May 15, 4 p. m.	Large albino rabbit, No. 12, about 4 years old.	Treated with ammopia similarly to the foregoing.	Died May 18, 4 p. m., 73 hours after inoculation. Animal seemed not to suffer and took food well; death in convulsions, which lasted about 3 hours.	External wound as well as that of the trachea had perfectly healed. Lesions perfectly similar to those of foregoing rabbit only less intense in degree. Tubercles more scarce; lungs less hyperæmic and less infarcted. No micrococci in blood; pseudo-membrane fully developed and perfectly similar to foregoing. Bacteria and micrococci present in membrane and in lungs, but none in other organs.
48	May 28, 12 o'ck.	Albino rabbit, No. 7.	Treated with ammonia like foregoing rabbits, Experiments 46 and 48.	Died May 30, 11 a. m., 71 hours after operation.	Lesions fully indentical with last rabbit, Experiment 47.
49	May 28, 12 o'ck.	Cat, No. 7.	Same as last experiments, 46, 47, and 48.	Died May 30, 2 p. m., 50 hours after operation.	Lesions and well-developed false membrane similar to those in the last three rabbits, but here absence of tubercles. No micrococci in blood, and none in organs.

FOURTH SERIES OF EXPERIMENTS.

Injection of ammonia into the trachea—Continued.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examinations.	Remarks.
50	May 28, 12 o'ck.	Dog, No. 3.	Same as last	Great difficulty of breathing and inability to swallow followed the operation, but animal was artificially fed with milk, &c.; 12 days after the operation seemd to be recovering; killed June 9.	Body much emaciated; skin wound healed, while tracheal wound was open yet; slight congestion of tissues around trachea. In many places on the mucous membrane of trachea traces of disappearing false membrane seen; whole trachea covercred by thick tenaceous mucus containing large quantity of leucocytes, some giant cells, and bacteria in moderate quantity. Spleen highly tubercular, tubercles in liver, lymphatic glands, and some in lungs. No bacteria in blood taken from jugular vein immediately after death.	
51	June 8, 4.30 p. m.	Fresh rabbit, No. 25, about three months old.	Treated with ammonia similarly to the foregoing five experiments, 46, 47, 48, 49, 50.	Died June 9, 4 p. m.; no convulsions.	Autopsy made immediately after death. Wound in skin healed; tracheal wound open; the tissues around the latter strongly hyperæmic; trachea nearly filled by false membrane. A tested preparation of membrane taken five minutes after death showed the usual elements of a natural diphtheritic membrane with great abundance of bacteria; the blood did not contain bacteria. Lungs much congested; its vesicles largely filled with the crupous exudation, blood corpuscles, and bacteria. All other organs normal and not containimg bacteria.	
52	June 8, 4.30 p. m.	Rabbit, No. 26.	Same as last	Died from effect of operation, too much ammonia having been given.		

FIFTH SERIES OF EXPERIMENTS.

Inoculation with foreign bodies, pus, &c., in the trachea.

53	May 19	Large rabbit, No. 14. See Experiment 21.	Inoculated in the trachea with slough from a bed sore.	Wound healed rapidly, the animal recovering completely.		
54	June 3	Small rabbit, No. 28. Fresh rabbit.	Inoculated in the trachea and in the thigh muscels with exudation from throat of a scarlet fever patient.	Died June 12	Large cheesy lump on thigh. Some congestion and translucent mucus around tracheal wound which had not healed; no false membrane. No lesions in the organs; not examined for bacteria.	Case X.—From Dr. Fulton, the matter being produce of ulceration of a scarletinal sore throat.
55	June 3	Small rabbit, No. 29.	Inoculated in the trachea only with the same matter as last.	Died June 10	Skin wound healed; upon dissection a cheesy abscess found below subcutaneous tissue, pressing upon the trachea, and probably having been the cause of death. No other lesions perceptible. No bacteria in blood. None in organs.	
56	June 8	Small rabbit, No. 30.	Inoculated in trachea with the pseudo-membrane produced by ammonia in rabbit No. 25, Experiment 49.	Animal well June 18.		
57	June 8	Small rabbit, No. 31.	Same as last	Killed June 16	No lesions except congestions of trachea and large cheesy lump between the trachea and skin.	
58	June 8	Small rabbit, No. 32.	Inoculated in trachea with purulent mucus taken from trachea of dog No. 3, Experiment 48.	Died June 11	No lesions in any organ perceptible; tracheal wound not healed. No bacteria in blood.	
59	June 9	Large rabbit, No. 33.	Inoculated with ichorous pus in trachea.	Animal well		
60	June 10	Small rabbit, No. 34.	Inoculated with pus in trachea.	Found dead June 11	No lesions except congestion of trachea.	
61	June 10	Small rabbit, No. 35.	Same as last	Died June 18	Large cheesy lump between skin and trachea. Wound in trachea not healed; on opening the trachea a distinct pseudo-membrane of from 1 to 1½ millimeters in thickness was found, prominently seen only below the tracheal wound, *i. e.*, in the lower half of the trachea and the bifurcation. Microscopically, this membrane was identical with the natural diphtheritic membrane and with those produced by introduction of ammonia, and of diphtheritic matter in the trachea.	

FIFTH SERIES OF EXPERIMENTS.

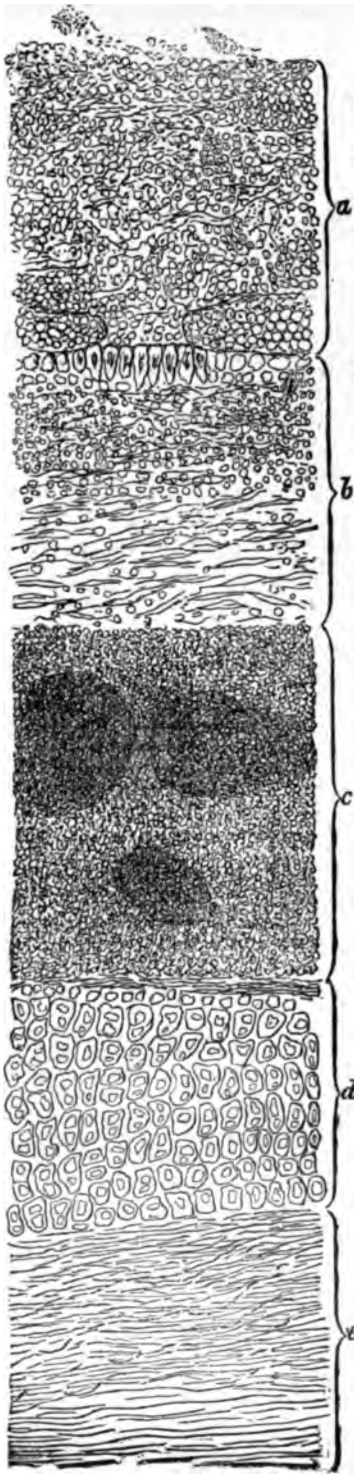
Inoculation with foreign bodies, pus, &c., in the trachea—Continued.

Number of experiment.	Date.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
62	June 10	Small rabbit, No. 36.	Inoculated with ichorous pus in trachea, and also deep in muscle.	Died June 17	Bacteria in large quantity all over. Cheesy abscess was found in the left lung; many air vesicles of both lungs filled with a croupous exudation containing multitudes of bacteria, prominent miliary tubercle in all organs. No bacteria in the kidneys; blood not examined. Large cheesy lump upon trachea, the latter much congested. Within the trachea a very distinct pseudo-membrane was developed in the lower half, like in last experiment and of the same mecroscopic and microscopic character. Croupous inflammation of lungs. Other organs normal.	

In looking over the last table, it will be seen that in two of the ten experiments pseudo-membranous trachitis was caused by the introduction of organic matter into the trachea. In both of the cases in which false membrane was produced the injected material was pus; and it will be noticed that only four such experiments were made, so that the proportion of successful result is very large, much larger indeed than with true diphtheritic exudation in our experiments.

Trendelenburg found that not only ammonia, but also various other chemical irritants are capable of causing the formation of false membrane in the trachea; many years since it was proven that tincture of cantharides will do the same thing. It would seem, therefore, that in the trachea the fromation of a pseudo-membrane is not the result of any peculiar or specific process, but simply of an intense inflammation, an inflammation which may be produced by any irritant of sufficient power. This fact, certainly, is very suggestive in regard to the pathology of diphtheria, and whilst we are not prepared to commit ourselves to any theory, it does seem proper to call attention to certain facts as indicating a very simple explanation of the peculiarities of the disease.

It is certain that as in the lower animals, so also in man, will chemical irritants produce a pseudo-membranous trachitis; we are also well assured that there is no anatomical difference which can be detected with the microscope between the lesions of true croup and diphtheritic angina. A difference has been believed by some pathologists to exist between the two diseases, in that in croup the membrane separates easily; in diphtheria with great difficulty from mucous membrane. This seems to arise from a misunderstanding. The mucous membrane of the fauces and mouth has a squamous not easily detached epithelium, and consequently membrane connected with or springing from such surface is firmly adherent. The epithelium of the trachea is columnar, ciliated, and detaches with the utmost facility even in normal condition of the organ; hence membrane attached to it separates readily. The membrane of diphtheritic trachitis is always readily detached in the line of the epithelium. Our preparations also show that the exudation of the croupous inflammation excited artificially in the trachea is not merely superficial, but also extends below the basement membrane. Some of the best clinical authorities of the day teach that there is no essential clinical difference between true croup and diphtheria, cases commencing apparently as local sthenic inflammation and ending as the typical adynamic systemic poisoning. Every practitioner must have seen cases of angina in which he was in doubt whether to call the affection diphtheria or not; the very frequent diagnosis of



Transverse section of trachea with artificially-produced (by ammonia) pseudo-membrane. Rabbit No. 26. Experiment 52. Wood and Formad. Magnified 250.

a. Superficial pseudo-membrane. *b.* Croupous exudate below basement membrane. Between *a* and *b* are seen some remains of surface epithelium. *c.* Ecchymosis in submucous tissue and infiltration of tracheal glands with blood corpuscles. *d.* Cartilage. *e.* Outer connecting tissue and muscular investment.

"diphtheritic sore throat" is a strong evidence of this. There have been cases in which diphtheritic matters absorbed by a wound have produced symptoms very closely resembling those of ordinary septic blood-poisoning from post mortem wounds, &c.; there have beencases of the formation of false membrane about wounds, &c., without any known exposure to a specific diphtheritic poisoning, indicating that the systemic tendency to this peculiar form of exudation is capable of being engendered by other than the specific poison of diphtheria; finally, diphtheria seems sometimes to be produced by exposure to cold.

A general view of these facts seems to indicate that the contagious material of diphtheria is really of the nature of a septic poison which is also locally very irritant to the mucous membrane; so that when brought in contact with the mucous membrane of the mouth and nose it produces an intense inflammation without apsorbtion by a local action. Whilst absorption is not necessary for the production of the angina, it is very possible that, the poison may act locally after absorption by being carried in the blood to the mucous membrane. Further, under this theory it is possible that the poison of diphtheria may cause an angina which shall remain a purely local disorder, no absorption occurring, or a simply local trachitis produced by exposure to cold, or some other non-specific cause, may produce the septic material when absorption shall cause blood-poisoning, the case ending as one of adynamic diphtheria.

Some such explanation as those here offered seems to reconcile the antagonistic opinions concerning the value of local treatment in diphtheria; because it is plain that the value of such treatment must largely depend upon whether the angina has or has not been preceded by absorption.

There is one more important clinical feature of the disorder, which under other views of the disease seems inexplicable, but which with the present theory is easily explained. Diphtheria differs from the exanthemata by the fact that one attack in no way protects against a second. It will be seen that the theories here put forward remove the affection entirely from any relation with exanthemata, placing it rather with septic diseases, which, as is well known, may recur indefinitely.

We want, however, distinctly to state that we do not consider these ideas to be more than suggestions, and it is useless to speculate, except as a guide to further experimental research. It doesseem to us that there are now two pathways clearly open, which, if carefully followed, must lead to important positive or negative results. The first of these consists in the making of careful culture experiments to determinewhether there is or is not any difference between the bacteria of ammonia and diphtheritic false membranes; the second, the study of the induction of epidemics of pseudo-membranous angina and trachitis in the lower animals, and the relation to these of the rapid cases of death produced in the lower animals by diphtheritic inoculation.

There is still another somewhat different view, which seems also not repugnant to the known facts of the case. There may be bacteria, which, although they offer no points of difference detectable by our best microsocopes, are really very diverse. Two spermatozoa or two ova in the higher animals may seem to be exactly alike and yet be potentially widely separated. Although, therefore, the bacteria of an ammonia false membrane seem identical with those of a diphtheritic false membrane, they are not of necessity really so. Careful studies of the blood of patients who die of diphtheria should be made, but at present it seems altogether improbable that bacteria have any direct function in diphtheria, *i. e.*, that they enter the system as bacteria and develop as such in the system and cause the symptoms. It is, however, possible that they may act upon the exudations of the trachea as the yeast plant acts upon sugar, and cause the production of a septic poison which differs from that of ordinary putrefaction, and bears such relations to the system as to, when absorbed, cause the systemic symptoms of diphtheria. Now, these bacteria may be always in the air, but not in sufficient quantities to cause trachitis, but enough when lodged in the membrane to set up the peculiar fermentation; whilst, during an epidemic, they may be sufficiently numerous to incite an inflammation in a previously healthy throat.

UNIVERSITY OF PENNSYLVANIA, *July* 1, 1880.

APPENDIX H.

REPORT OF MICROSCOPICAL EXAMINATION OF SUSPENDED PARTICLES FOUND IN THE ATMOSPHERE.

BY GEORGE M. STERNBERG, *Surgeon, U. S. A., Secretary of Havana Yellow Fever Commission.*

INTRODUCTION.

The following brief report contains a summary of the results obtained by the writer up to the present time (January, 1881) in his studies of "dust," or the suspended particles found in the atmosphere.

These studies were commenced in Havana, and have since been continued in Washington City and in New Orleans, in compliance with instructions contained in a communication from the secretary of the National Board of Health dated December 27, 1879.

A considerable portion of my time has been devoted to these researches, both in Havana (as a member of the Yellow Fever Commission) and in New Orleans, but I have not considered the results of sufficient value to justify me in placing upon record a detailed account of all the observations made.

The most important result is, in my opinion, the conclusion which I have reached, and which agrees with the observations of Cunningham, Miguel, and other observers, that bacterial organisms are not found in the atmosphere, even in crowded cities in a southern latitude and during the summer months, in any considerable number, in a recognizable form, and consequently that the method by direct examination, which I have chiefly employed, does not give promise of definite results in regard to the supposed relation of these minute organisms to the prevalence of epidemics.

As, however, the presence of germs not recognized by direct examination, is demonstrated by the abundant development of bacterial organisms in sterilized organic liquids exposed to the atmosphere, it is hoped that the method by culture experiments, in which a variety of organic liquids, exposed in different localities, at different seasons, and during the presence and absence of epidemics, may give better results.

The careful study of organisms developed in such liquids, the isolation and cultivation of special forms with a view to testing their physiological action upon animals, and experiments relating to the production of pathogenic varieties of common and usually harmless bacteria, present a broad field for experimental investigation which, I believe, will not prove so barren of important results as have the methods heretofore chiefly relied upon.

REPORT.

Ehrenberg first studied dust in 1830, and in 1848 devoted himself to a search for the cholera germ. Since this time numerous attempts have been made to throw light upon the etiology of epidemic diseases by the study of infected atmospheres. The generally accepted view as to the particulate nature of disease poisons, the indisputable evidence of their presence in the atmosphere during the prevalence of pestilential diseases, and the increasing interest in microscopical studies which has been developed *pari passu* with the perfecting of the microscope, have induced many persons to devote more or less time to these investigations. Prominent among these investigators are the names of Ehrenberg, Robin, Gaultier de Claubry, Pouchet, Pasteur, Joly, and Musset, and Miguel, of France; and Swayne, Britton and Budd, Thompson, Samuelson, Parkes, Hewlett, Maddox, Cunningham, Angus Smith, Sanderson, Dancer, and Tyndall, of England.

It must be admitted that so far as the main object of these studies is concerned, no definite results have been achieved. The subtle germs of disease have either eluded observation because of their minute size, or have escaped recognition among the multitude of particles of various kinds which make up the "dust" found everywhere suspended in the atmosphere.

It is evident that an acquaintance with the harmless organisms found in the atmosphere during the absence as well as during the prevalence of epidemics is a necessary prerequisite to the intelligent study of an infected atmosphere. To one unfamiliar

with these organisms the spore of a common cryptogam or a pollen grain is a possible disease germ. It is, therefore, necessary that the investigator possess some knowledge of these more conspicuous objects before attempting to study the minute granules, barely visible with the highest powers, among which, if at all, the objects of our research are most likely to be found. My experience in Havana, the results of which will be detailed hereafter, convinced me of the importance of such preliminary studies and has induced me to supplement my first efforts, necessarily unsatisfactory from my own experience, and the brief time allotted to the Havana investigation, by subsequent experimental researches in New Orleans, and by a review of the literature relating to this subject. It is my intention to give in this report a general account of the results obtained by myself and by other observers in various parts of the world, in the microscopical analysis of the suspended particles in the atmosphere, known vulgarly as "dust."

The grosser materials which make up the bulk of the dust always present, in greater or less amount, in the lower strata of the atmosphere, are readily obtained from surfaces upon which deposition has taken place, from articles of furniture, window-ledges, &c., in dwellings and hospitals; from roofs of houses, the surface of leaves, fruits, &c. An excellent method is to expose glass slides in sheltered locations for a day or two; the dust which is deposited adheres to the surface with considerable tenacity and is conveniently distributed for microscopical examination.

This method, however, gives an excess of the earthy particles and the grosser kinds of organic *débris*, which possess but little value for the microscopist, who is chiefly interested in the study of the organisms present in the atmosphere, which, although sometimes deposited with this grosser material,* are obtained in greater number, and in better condition for examination by other methods.

The method which has given the best results, and which I have used in my own studies, consists in the projection of a current of air passing through a small aperture against a glass slide having a little glycerine or other viscid liquid smeared upon its surface. It matters not whether the air be projected against the glycerined slide by the natural force of the wind, as in the apparatus of Maddox used by Cunningham and Miguel (see Fig. 3, Plate I), or by a propelling force, as in the apparatus of Klebs and Tommasi Crudeli, Fig. 2, Plate I, or by aspiration, as in the apparatus which I have employed, Fig. 1, Plate I. The latter method, however, admits of the introduction of my metal case (Fig. 4, Plate I), which is used in connection with a water aspirator, into sewers, holds of ships, &c., where the aeroscope of Maddox would not be available.

Other methods are, that employed by Pasteur, in which air is filtered by passing through cotton, from which the particles are subsequently washed, or through gun cotton, which may be dissolved in ether, and the method by precipitation of atmospheric moisture upon artificially refrigerated surfaces.

The nature and quantity of the particles collected by any of the forms of apparatus referred to will vary in accordance with circumstances relating to location, elevation, season, meteorological conditions, &c.

In dwellings, hospitals, &c., a considerable portion of the dust collected consists of fibers of wool, linen, and cotton detached from clothing, bedding, carpets, &c., and of epithelial cells from the surface of the human body, mingled with more or less amorphous inorganic material and animal and vegetable *débris* of various kinds.

In the open air particles of mineral origin are more abundant. The nature and quantity of these depend, of course, upon the character of the soil in the vicinity, the force of the wind, &c.

Crystals.—I have met with several forms of crystals in my examinations of dust deposited upon the surface of glass slides exposed in various locations. The most common form is that shown in Fig. 4, Plate II. These crystals I have found quite frequently upon glass slides exposed in hospitals, in my laboratory, on ships, &c., both in Havana and in northern localities. They seem to be identical with crystals figured by Miguel as found in the atmosphere of Paris, and there is no good reason to suppose that they bear any relation to the prevalence of epidemic diseases. I have also found quite frequently associated with these minute navicular-shaped crystals, having sometimes one and sometimes both extremities acute. Again, I have occasionally found upon slides ,exposed in the vicinity of salt-water, cubical crystals of sodium chloride. Of greater interest are the crystals shown in Fig. 5, Plate II, which, so far as I know, have not been described by any previous observer, and of which I give the following account in the preliminary Report of the Havana Commission:

"Attention was particularly attracted to certain slender glistening acicular crystals radiating from little opaque masses, which were especially abundant in the yellow-fever wards and in the soiled linen room of the military hospital. Subsequent observations in the United States have added to the interest which these striking objects

* The experiments of Professor Tyndall, in which he uses a beam of light as the most delicate test of the presence of floating particles in the atmosphere, prove that in a closed chamber where the atmosphere is undisturbed a complete deposition of all suspended particles occurs after a time.

aroused when first seen. Soon after the return of the Commission the National Board of Health had a session in Washington, and several of the members on returning to their homes took with them some watch-glasses arranged in little boxes, so that they could be conveniently packed and sent by mail. These watch-glasses were exposed in various places, and returned to Washington for microscopic examination of the dust deposited upon them. They were received in good order, and had adhering to the concave surface of each glass a deposit of dust more or less abundant, according to the place of exposure. Seven boxes, each containing two glasses, were received from infected localities, viz, two from Morgan City, La., four from Centreville, La., and one from Bayou Bœuf.

"Of these, six pairs of glasses had been exposed in the rooms occupied by yellow-fever patients, and one pair outdoors, in an infected locality. All of these glasses were found to have adhering to them a considerable number of radiating acicular crystals, exactly similar in appearance to those discovered in Havana. Eight boxes were also received from places supposed to be not infected, viz, four from Bellevue Hospital, New York, and four from Charity Hospital, New Orleans. The watch-glasses inclosed in these boxes had been exposed in the wards of these hospitals and in the dead-house and soiled-linen room of Charity Hospital. All were well covered with a deposit of dust, and none of those from New York presented any appearance of crystals. The glasses from New Orleans, however, had a very few of the acicular crystals described."

Samples of dust collected in the same way were subsequently obtained from hospitals in Boston, Philadelphia, and Mobile, and from the Soldiers' Home, Washington, D. C. None of these specimens contained the crystals described except those from Mobile. As there had been no yellow fever in this city during the year, the finding of the crystals here makes it extremely improbable that they bear any direct relation to this disease. But having been found only in southern localities, Havana, Morgan City, New Orleans, Mobile, Memphis, and during the season when yellow fever is likely to extend when introduced, the possibility remained that they might indirectly bear some relation to the epidemic extension of this disease. I have therefore made, during the present summer, additional researches by the same method. I have exposed slides on several occasions in the linen-room and wards of Charity Hospital, New Orleans, in my laboratory in the same city, and in the vaults of Lafayette Cemetery, but have not in any instance found the crystals which were so common on the surface of slides similarly exposed during the preceding summer. To test the question as to whether similar crystals would be formed in an atmosphere loaded with the volatile products of putrefaction, I exposed slides for many days under a bell-jar with putrefying meat-juice, but with negative results. Again, I exposed slides for forty-eight hours, in midsummer, in the vicinity of the "mill-pond," Salem, Mass. This locality is noted for its foul odors and insanitary surroundings, but it did not furnish any specimens of the crystals for which I was looking. My investigations, then, in relation to these crystals, have not led to any definite results in the way of determining their nature or significance. Soon after my return from Havana, my friend, Surgeon J. J. Woodward, called my attention to the fact that slides which have been kept in a cabinet for a long time often have upon their surface a considerable number of crystals, some of which exactly resemble the acicular crystals found by me in Havana, and similar crystals have been found "upon glass slips exposed in the air of various apartments in Washington during the months of June and July, 1880." (Report on Yellow Fever in the U. S. S. Plymouth in 1878-'79; Navy Department, Bureau of Med. and Surg., 1880.)

INORGANIC MATERIAL AND ANIMAL AND VEGETABLE DÉBRIS OF VARIOUS KINDS.

Out of doors particles of mineral origin are most abundant. The nature and quantity of these depend, of course, upon the character of the soil in the vicinity, the force of the wind, &c.

Vegetable debris.—In Havana and in New Orleans I have always found in my aspiration experiments a considerable quantity of vegetable *débris*, consisting of epidemic pellicles, fragments of cellular tissue, hairs of plants, and broken-down structureless masses. A mass of this kind, inclosing starch grains—probably banana—is shown in Fig. 1, Plate II. As these floating fragments are doubtless, in great part, derived from vegetables thrown into the streets, from garbage piles in out-of-the-way places, from the droppings of animals, and from decomposing algæ and plants of various kinds upon the margins of the gutters and canals in New Orleans, we have every reason to suppose that the respiration of an atmosphere loaded with such particles must have an unfavorable influence upon the health of those who are compelled to respire it. Although direct proof of this may be wanting, the prevalence of diarrhœal diseases, and the general lowering vitality among those who reside in localities especially subject to this kind of atmospheric contamination, makes it seem not improbable that this is an important factor in the production of disease. During the summer months, when putrefactive processes are active in the decomposing masses from which many

of these microscopic fragments are detached, we have a direct transfer from the gutters and garbage piles to the numerous surfaces of the respiratory passages of man, not only of these particles of vegetable tissue, undergoing retrograde changes, but of the minute organisms attached to their surfaces which are the direct agents of these putrefactive processes.

The glycerined slide, in the form of aspirator, which experience proves is most successfully employed in arresting the particles suspended in the atmosphere, must be very much inferior to the extended mucous surface over which the inspired air gently plows before reaching the lungs of man, and we have every reason to believe that the expired air is returned to the atmosphere, free from the freight it carried upon entering the mouth or nares. This furnishes doubtless a necessary protection to the delicate tissues of the lungs, but it especially exposes us to whatever danger there may be from the retention of poisonous particles suspended in the atmosphere. The quantity of soot or dust which may thus be deposited upon the mucous membrane of the nares during a short railroad journey has doubtless attracted general attention, but the amount of more deleterious but less conspicuous material which may be thus deposited is a matter which, perhaps, has not received sufficient consideration.

It is evident that poisonous particles deposited in this way, if not absorbed directly from the mucous membrane, will find their way to the stomach with the saliva swallowed, while living germs will find in the human mouth and alimentary canal a warm and moist culture-apparatus, admirably adapted to the growth and multiplication of many species, as is proved by their constant presence there. (See Fig. 2.)

Animal debris.—The most common particles of animal origin are epithelial cells of man and animals—hair, fur, wool, fragments of feathers, the bodies of minute insects and broken fragments of larger ones, scales from the body and wings of lepidopterous insects, and from the mosquito (see Fig. 9, Plate II), &c.

Infusorial animals are not found in the atmosphere in a recognizable form, probably because their soft bodies are quickly dessicated and broken up when removed from a liquid medium. The eggs, or germs, of certain species are, however, sufficiently common, as is proved by the development of adult forms in pure water exposed to the air. I have found an abundance of *Monas lens* in distilled water kept in my laboratory, and the observations of Sanderson, Cunningham, Mignel, and others are to the same effect. The last-named author has given special attention to this subject, and estimates that there is an average of one or two infusorial eggs in ten cubic meters of air. As the result of carefully conducted experiments, in which rain-water was caught and inclosed in vessels purified by heat, Miguel makes the following statement:

"From these precise experiments it results that the eggs of the monads, of cercomonads, and of the rhizopods, are those which are the most widely distributed in the atmosphere."

Vegetable organisms.—The spores of cryptogams and pollen grains are the most conspicuous and most abundant vegetable organisms found in the atmosphere of New Orleans, as elsewhere. I have made many photomicrographs of the more common forms, but am only able to introduce a limited number of these in illustration of the present report, as the heliotype reproduction of my negatives would be attended with considerable expense, owing to the fact that usually but one or two spores are found in a single field, and consequently in each negative. I have therefore borrowed from the amply illustrated and admirable report of Cunningham (Microscopic Examinations of Air by D. Douglass Cunningham, Surg. H. M. Indian Med. Service: Report of Sanitary Commission with the Government of India, 1872), some figures (Fig. 5, Plate I) which illustrate at the same time the general appearance of the organisms found by him in the atmosphere of Calcutta, and by myself in New Orleans. While some of the figures drawn by Cunningham doubtless represent the spores of cryptogams peculiar to low latitudes in the eastern hemisphere, many of them do not differ from forms found by me in New Orleans, and belong to widely diffused species, *e. g.*, *Penicillium glaucum*, the spores of which are represented in my Fig. 8, Plate II, and the spores of a species of Botrytis (?) represented in Fig. 2, Plate II.

I judge from Cunningham's report and figures that certain cryptogamous plants, and especially the coniomycetous fungi, are more abundant in the vicinity of Calcutta than at New Orleans, where I have found the spores of *Penicillium* and minute hyphomycetes in relatively greater numbers than is indicated in this author's drawings. These differences, of course, depend upon season, climate, and local surroundings. Thus, in a vicinity where the grasses and cereals are extensively cultivated the fungi parasitic upon these plants would be most numerous, while in a locality surrounded by forests or swamps other species would abound. Miguel (*Etude sur les poussiéres organisée des l'atmosphère*, Annales d'Hyg. Pub. 1879, pp. 226–255, and 333–362), whose investigations, made at the observatory of Montsori, Paris, are the most recent and the most thorough of any with which I am acquainted, gives the following account of the spores of cryptogams found in his researches:

"The most abundant microbes are, without doubt, the spores of molds, the white and glaucous spores of *Penicillium*, the brown and greenish spores of *Aspergillus*, of *Core-*

mium, and of some species of *Botrytideæ*. The family of the *Torulaceæ* is also very largely represented among the productions held in suspension in the atmosphere. It would be difficult for us to indicate with exactitude the genera and species of these cryptogams which live and fructify in water and in nutritive liquids. Let us mention next the presence of numerous spores of the genera *Septonema*, *Alternaria*, *Dactylium* which we have been able to cultivate upon wood and upon cotton saturated with water. Let us indicate, in passing, the septate spores of *Leptotrichum*, of *Trichothecium*, of *Septosporium*, the spiral spores of the genus *Helicotrichum*, so abundant in the air after a rainy season, and those of the genus *Ceratocladium*, of which the form is comparable to an ergot of rye. The air of Paris is also loaded at all seasons with a crowd of *Fusidium*, of *Selenosporium*, of which some in growing emit myalial threads from their pointed extremities, while many smooth, eliptical spores have as many as three or four myalial sprouts placed at different points of their circumference. Let us mention next the fructifications of the *Gonatobotrys*, of the *Arthrobotrys*, and the spores of a crowd of mucors, and of the caspore fungi. It is probable that certain fructifications, which it has been impossible for us to cultivate, belong to these voluminous fungi filled with several millions of spores. Let us mention, finally, some *Isaria*, which may be cultivated upon paper suitably moistened with ordinary boiled water, and we will have given but a very feeble idea of the innumerable variety of micro-germs suspended continually in the atmosphere. It is equally easy to discover in the dust carried by the winds numerous spores of lichens of mosses, and of all the cryptogams which give by dehiscence microscopic fructifications."

The considerable numbers and extensive distribution in the atmosphere of these spores of common cryptogams is, *a priori*, argument in favor of their harmless nature, and the researches which have thus far been made give support to this inference. Cunningham, after a painstaking investigation made in Calcutta, during the year 1872, sums up the results of his studies as follows:

"Spores and other vegetable cells are constantly present in atmospheric dust, and usually occur in considerable numbers; the majority of them are living and capable of growth and development; the amount of them present in the atmosphere seems to be independent of conditions of velocity and direction of wind, and their numbers are not diminished by moisture.

"No connection can be traced between the number of bacteria, *spores*, &c., present in the air and the occurrence of diarrhœa, dysentery, cholera, ague, or dengue, nor between the presence or abundance of any special form or forms of cells and the prevalence of any of these diseases."

So far as the diseases referred to are concerned, and as regards the more conspicuous spores of cryptogams commonly found in the atmosphere, the conclusions of Cunningham are probably correct. There is, however, some evidence that the spores of certain fungi may produce specific deleterious effects upon the human economy when inspired or injected into the circulation, and that the spores of certain common species, ordinarily harmless, may acquire, under exceptional conditions, hurtful properties. The anæsthetic properties of the "smoke" of the common puff-ball (*Lycoperdon proteus*) are well established. Mr. B. W. Richardson has found it possible to produce complete anæsthesia in animals—dogs, cats, and rabbits—by causing them to respire the fumes of this fungus. (Medical Times, Lond. N. S., vol. vi, 1853, p. 610.)

The cases and experiments reported by Saulsbury (Am. J. M. Sc., vol. xliv, 1862, p. 19) seem to prove that headache, catarrhal symptoms, and in some cases an eruption resembling that of measles, may be produced by respiring the emanations from moldy straw.

Somewhat similar effects have been observed in France to result from handling moldy seeds. (Jour. de Méd. Pratique de Montpellier, vol. i, p. 352.)

The doctrine of the polymorphism of these low forms, which numbers among its adherents many able naturalists (de Bary and others), opens a wide field for speculation and for experimental inquiry. But still more pregnant with important possibilities are the facts reported by Grawitz, which seem to show that the well-known fungi, *Aspergillus* and *Penicillium*, may undergo certain modifications as the result of a special method of cultivation, which change entirely their physiological action when introduced into the human body, without, however, producing any morphological changes in the fungus. Recent experiments seem to show that among the bacteria, which I am not at present considering, as I believe them to be more properly classed with the algæ, this change in physiological properties, as the result of cultivation in special media, is a not unusual occurrence; and there is a growing tendency, based upon experimental evidence, to explain the supposed noxious effects of the microphites found in the blood of certain diseases, especially of anthrax, upon the hypothesis of a change of this kind occurring in common forms rather than by the more widely accepted theory of independent and distinct species, morphologically not distinguishable the one from the other. The conclusions of Grawitz, whose experiments are above referred to, are as follows:

"1. The mold fungi, the best known of all and universally destributed, the *Eurotium*

(Aspergillus) and *Penicillium*, appear in two varieties, morphologically entirely alike, physiologically very different. One variety behaves with complete indifference in the circulation of the higher animals; the other must be assigned, as to malignancy, to the most virulent group of pathogenetic fungi known up to the present time.

"2. It is proved by experiment that both varieties can originate from any selected primary form by continued breeding, and likewise that each variety can be obtained from the other by systematic culture after about twelve to twenty generations.

"3d. The principle of breeding depends upon gradually accustoming fungi living in firm, weakly acid soil at a temperature of about 8° to 20° C., through a series of generations, to alkaline albuminous solutions having a temperature of 38° to 40° C.

"4th. The malignancy of the pathogenetic mold-fungi consists, in acute cases, in the fact that their spores, so soon as they arrive in the circulation of the higher mammalia, germinate there, pass into the different tissues of the body, develop among them, and produce local necrosis, which causes the death of the animal in about three days." (Virchow's Archiv. Bd. 81, p. 355.)

The Saccharomycetes, Nägeli, are widely disseminated in the atmosphere, as is proved by culture experiments with saccharine liquids which, when exposed to the air, soon give evidence of the presence of these budding cells, upon microscopical examination, and by the production of the alcoholic fermentation due to their presence. They are found, especially, in considerable numbers, attached to the surface of fruits (Pasteur).

Pollen.—The quantity of pollen carried by the winds is often very considerable, and from the varied and sometimes characteristic forms of these cells a microscopical examination may often determine the order or even the genus of plants from which they are derived, thus tracing them in some instances to distant localities. In the atmosphere of New Orleans, during the spring months, the pollen of the pine, Fig. 7, Plate II, is sometimes so abundant that after a rain it forms a yellow deposit upon the margins of the gutters. My friend, Dr. Devron, of this city, informs me that it is a popular superstition that this yellow deposit portends the occurrence of an epidemic of yellow fever later in the season.

I introduce Fig. 1, Plate II, which is from the pollen of *Carolinia*, a tree from Guiana, not as a specimen of pollen found in the atmosphere of New Orleans, but as a good example of the capabilities of photomicography in the representation of objects of this kind.

Pollen is, of course, more abundant in the spring of the year, and, as with the spores of cryptogams, the quantity and variety vary according to latitude and local surroundings. Miguel says:

"In order to give an idea of the abundance of these articles, we will say that in April, May, and June they are to the larger spores of the cryptogams as 1 is to 20, and that it is not rare to count several thousands of them in a single gathering."

Beyond the effect attributed to the pollen of certain grasses in the production of the disease known as hay asthma or summer catarrh, I know of no evidence going to show that the pollen suspended in the atmosphere plays a *rôle* in the production of disease.

Starch granules.—The considerable number of starch granules which, in common with other observers, I have found everywhere present in the atmosphere, was at first a matter of surprise to me. In my aspiration experiments, whether made in my laboratory in Havana or in New Orleans, in hospital wards, or in the streets, market places, and cemeteries of the cities mentioned, I have rarely failed to find a certain number of starch granules in every sample of dust obtained by the passage of ten gallons of air through my aspirator. When we consider the abundant presence of starch granules in the stems and leaves of certain plants, as well as in fruits and vegetables, and the fact that they are set at liberty, but not destroyed, by the putrefactive changes under which the cellular tissue breaks down, their abundant presence in the atmosphere is no longer surprising, In numerous culture experiments conducted in my laboratory in New Orleans, in which the pulp of various fruits and vegetables was kept under observation for two or three months for the purpose of studying the bacteria and fungi developed from air-borne spores, I have invariably found that the starch grains remained unchanged long after the cellular tissue which surrounds and incloses them has yielded to putrefactive processes.

"Starch grains seem to compose about the one-hundredth part of the organized productions carried by the winds."

Algæ.—Doubtless many of the amorphous particles of vegetable tissue found in the atmosphere are the desiccated fragments of confervoid algæ, but I have not found recognizable portions of the *confervæ*, or specimens of the *Desmideæ*, or of the *Diatomaceæ* in my researches.

This experience agrees with that of Miguel, who, however, has frequently met with the cells of Clorococcum, Protococcus, and Palmella. These genera are also represented by occasional cells in the air of New Orleans.

BACTERIA (*Schizomycetes*, *Nägeli*). Especial interest attaches to the question of the presence in the atmosphere of the minute algæ known under the general name of bac-

teria, because of the *rôle* of these organisms in putrefactive processes, and the accumulating evidence in favor of the "germ theory" of disease.

My observations accord with those of Cunningham, who says:

"Distinct bacteria can hardly ever be detected among the constituents of atmospheric dust, but fine molecules of uncertain nature are always present in abundance.

"Distinct bacteria are frequently to be found amongst the particles deposited from the moist air of sewers, though almost entirely absent as constituents of common atmospheric dust."

While this is true as regards the rods, torula chains, and spiral filaments so constantly met with in microscopical examinations of liquids, yet there is indisputable evidence that the germs from which these various forms of bacteria are developed are constantly present and widely distributed in the atmosphere. Many of these germs are of sufficient size to be seen with high powers, but to differentiate them with certainty from the inorganic granules and organic *débris* with which they are associated must be a matter of great difficulty. Their presence is, however, easily demonstrated by culture experiments in which sterilized organic liquids are inoculated by exposure to the air, or by adding to them small quantities of dust collected by aspiration or otherwise. Miguel says:

"The *bacillaire algæ*, which some authors place in the animal kingdom, but which we call *vibrionicus*, are always found in the air in the state of germs, visible by the aid of high powers when one takes the precaution to color them yellow with iodine."

In a subsequent paper (*Comptes rendus*, Acad. d. sci. xci, 1880, p. 64) Miguel claims to have succeeded in counting the spores of bacteria, and asserts that while always present in the atmosphere their number is subject to constant variations.

"Very small in winter, the number increases in spring, is very high in summer and autumn, then sinks rapidly when frost sets in. This law also applies to spores of fungi; but while the spores of molds are abundant in wet periods, the number of aerial bacteria then becomes very small, and it only rises again in drought, when the spores of molds become rare. Thus, to the *maxima* of molds correspond the *minima* of bacteria, and reciprocally.

"In summer and autumn, at Paris, 1,000 germs of bacteria are frequently found in a cubic meter of air. In winter the number not uncommonly descends to four or five, and on some days the dust from 200 liters of air proves incapable of causing infection of the most alterable liquids. In the interior of houses, in the absence of mechanical movements raising dust from the surface of objects, the air is fertilizing only in a volume of 30 to 50 liters. In Miguel's laboratory, the dust of five liters usually serves to effect the alteration of neutral bouillon. In the Paris sewers, infection of the same liquor is produced by particles in one liter of air.

"Miguel compared the number of deaths from contagious and epidemic diseases in Paris with the number of bacteria in the air during the period from December, 1879, to June, 1880, and established that *each recrudescence of aerial bacteria was followed at about eight days' interval by an increase of the deaths in question.* Unwilling to say positively that this is more than a mere coincidence, he projects further observations regarding it" (quoted from Jour. of the Roy. Mic. Soc., vol. iii, No. 5, (October, 1880, p. 838).

While I have no reason to doubt that the more extended experience and superior technical skill of Miguel may have enabled him to give a certain value to these enumerations of the bacterial germs present in the atmosphere of Paris, I must confess that I have not felt sufficient confidence in my own power to differentiate with certainty veritable germs from pseudo germs of organic or inorganic origin, to induce me to make a similar attempt in New Orleans. For me, the capacity to grow is the only certain test of a living germ, and it is by testing this capacity in different media, and at different temperatures, and in carefully studying the life-histories of the organisms which develop from air-borne germs in different localities, at different seasons, and under varied conditions as to prevalence of disease, that I anticipate the most important contributions to our knowledge of the etiology of epidemic diseases.

Culture experiments.—I have made during the past two summers, both in Havana and in New Orleans, a variety of culture experiments designed to promote the development of the adult forms of organism represented by living germs suspended in the atmosphere. For this purpose I have used Cohn's fluid, urine, blood, animal and vegetable infusions, the pulp of various fruits and vegetables, &c. I have found a very suitable culture-fluid, especially for the saccharomycetes, to be the liquor from the interior of an unripe cocoanut. This liquor is preserved in a germ-proof receptacle—the shell—and, with proper precautions, may be drawn into a purified flask, without danger of contamination. Fish-gelatine solution, prepared in accordance with the directions of Klebs and Tommasi, seems to be a very suitable medicum for the cultivation of the schizomycetes, and in New Orleans I used it extensively and quite successfully, so far as the development of a variety of forms is concerned. My experiments have demonstrated the presence in the atmosphere of New Orleans, as elsewhere, of an abundance of germs of the common bacteria of putrefaction, but they do not seem worthy of being recorded in detail, as no new facts of value have been brought

statistics have as yet proved nothing, as to the origin, cause, or prevention of disease; it is only by studying the minute details of irregular sudden daily changes that we can hope to demonstrate the direct influence of the atmosphere, or to show those geographical regions to which, in a very limited class of diseases, patients may be advantageously sent for a beneficial change.

V. Since, therefore, our studies of climate and disease give us no satisfactory answer to the questions that we have at heart, we perceive that we must pursue a very different line of investigation. We must first inquire of the experimental students of human physiology as to the cause of disease, and as to what climatological features are of importance, and then turn to the meteorological records to find them, if we can—not to take the monthly averages that the meteorologist has prepared for his own special use.

I find that the following purely climatic considerations are the principal ones that experience and experiment have shown to directly affect the human system after it has once become acclimated to any given conditions:

1. Long-continued extreme hot weather, with light winds and calms, producing nervous debility.
2. Long-continued extreme moisture, checking perspiration and throwing back into the system the heat that would have been absorbed with evaporation.
3. Sudden changes from cool to hot.
4. Sudden changes from hot to cold.
5. Sudden changes from dry to moist.
6. Sudden changes from moist to dry.

In addition to these changes, those also from high to low or from low to high pressures are shown by many investigators to have probably a decided effect upon the organs of breathing.

In general, these six or eight conditions reduce to two or four, as most climates unite the change from cold to hot with the change from moist to dry, or *vice versa;* and in general, the atmospheric changes here specified determine the direct effect of the weather upon human health; and if we would bring out quantitatively the actual bearing that these features have upon humanity, we must not hide them under a mass of mean monthly or annual temperatures and humidities.

VI. If it be considered desirable to especially determine these particular features of any climate, the apparatus would be of the simplest kind, namely:

1. A self-registering maximum thermometer.
2. A self-registering minimum thermometer.
3. A maximum and minimum hygrometer; the hair or veneer hygrometer, having sliding indexes to record the extremes.
4. A self-registering maximum and minimum aneroid barometer, one having sliding indexes to record the extremes.

The observers' duties would consist in the record once a day, say at 9 p. m., of the indications of these instruments.

The statistician would then make out tables of the greatest range of temperature from the morning minimum to the afternoon maximum, and from the afternoon maximum to the next morning's minimum, together with any other items suggested by the physiological student.

VII. These items include, I believe, all the features of climate that directly affect human health, and the best method of presenting them in graphic form to the eye is simply a repetition of the maximum and minimum curves, illustrated by the diagram No. 7, or by a corresponding condensation from a daily into a monthly summary.

VIII. In conclusion, I must commend to your notice the well-weighed words of Dr. J. Shreiver, of Vienna, in a lecture on this subject in 1876, which, at my suggestion, has been translated, and made accessible to American readers, by Dr. Geddings, and in which the author maintains that we are wholly on the wrong path when we confine ourselves to comparing meteorological observations with medical statistics; and "that the term climate, which has been hitherto employed to denote a vague, indefinite specific, of which no rational account could be given, appears now as something infinitely clear and very simple, being in fact nothing more than pure air, uncontaminated by miasma, with no organic or inorganic substances, and one in which rain is not unduly deficient."

Note added in June, 1880.

The preceding paper deals only with the question of the direct influence of climate on health. It was not the author's intention at the present time to propose definite hypotheses in reference to germs or the numerous other indirect influences, but to show that certain diseases mentioned by him, and probably many others not mentioned, must logically or, as he believes, reasonably be attributed to the direct action of climate; that, therefore, we must turn our attention more than ever to other sources of disease.

APPENDIX L.

REPORT ON SANITARY SURVEY OF MEMPHIS, TENN.

WASHINGTON, D. C., *March* 1, 1880.

At the meeting of the National Board of Health, October 13, 1879, it was decided that a sanitary survey of the city of Memphis should be made, and a special committee of the Board, consisting of Drs. J. S. Billings, H. A. Johnson, and R. W. Mitchell, was appointed to take charge of the matter.

This committee was authorized to have made a house-to-house inspection, provided this was agreed to by the authorities of the city, and to employ two experts. It was also directed to visit Memphis at the close of the November meeting of the Board.

On the 21st of October the following resolution was received from the State Board of Health of Tennessee:

"Whereas proper sanitation, having for its object the promotion of the public health as applied to cities, can only be accomplished through the means of a thoroughly systematized and comprehensive plan, and the city of Memphis is now in such a condition as to demand the early adoption of a plan for future operations relating to its permanent sanitation; and

"Whereas the geographical position of Memphis and her relations by commercial intercourse place that city in a situation to imperil, in times of pestilence, the health of the whole Mississippi Valley; and

"Whereas neither the authorities of Memphis nor the board have the means at hand necessary to the accomplishment of this work: Therefore,

"*Be it resolved*, That the co-operation of the National Board of Health be requested for the purpose of making a thorough and complete sanitary survey of the city of Memphis at as early a date as possible, after the close of the present epidemic of yellow fever, with the view of indicating what conditions exist favorable to the production and spread of disease, and what measures should be adopted for their removal, with the methods of their accomplishment and the estimated cost of the same.

"Adopted at the quarterly meeting of the Tennessee State Board of Health, held October 7 and 8, 1879."

In accordance with a request made by the National Board, Hon. John Johnson, of Memphis, member of the State Board of Health of Tennessee, was designated to represent that body, and to aid and counsel with the committee having charge of the survey.

On the 30th of October a telegram was received from Hon. D. T. Porter, president of the taxing district of Shelby County, asking the National Board to make a complete sanitary survey of the city as soon as practicable, in reply to which he was informed of the action of the Board, and was requested to give such assistance toward making the examination complete and accurate as might be in his power.

At this time yellow fever was still prevailing in the city, and it was useless to undertake any house-to-house inspection or survey at that time, since the great majority of the inhabitants were absent and their houses closed. The necessary blanks for the house-to-house inspection were, however, prepared after an examination of a number of blank forms of a similar character. The form decided on measures 7 by 9 inches, and is as follows:

No. —. NATIONAL BOARD OF HEALTH. 1879

SANITARY INSPECTION OF MEMPHIS.

1. Ward ———, street ———, No. —.
2. Owner or owners, ———.
3. Area of lot, ———; of house, ———; out-houses, ———.
4. Age of house, ———; material, ———; No. of stories, ———.
5. Cellars and basement, ———.
6. Rooms and passages, ———.
7. Sinks, drains, and cess-pools, ———.
8. Privies or water-closets, location and condition, ———.
9. Yards, ———.
10. Hogs or other animals, ———; fowls, ———; No., ———; where kept, ———.
11. Public nuisances on or near premises, ———.

12. No. of families in house, ——; names of heads of families, ——; No. of persons in each, specifying No. of whites and blacks, ——.
13. Sickness now in house, ——; what diseases, ——.
14. Any sickness during past year, ——; what diseases, ——; No. of cases, ——.
15. Any deaths during past year, ——; what diseases, ——.
16. Water-supply, sources of, and sources of contamination, ——.
17. Presence of possibly infected material, ——.
18. Sanitary needs and estimated cost, ——.

The above is correct as personally examined by me this —— day of ——, 18—.
Refer to directions often.

—— ——,
Inspector.

Fifty such sheets were put together, forming a memorandum block, on the back of which was printed the following:

"DIRECTIONS.

"The figures below refer to the corresponding numbers on the other side. (See above.)

"1 and 2. Give the exact and full name of the owner or owners of the estate. Give the street and number, and describe the location so that it cannot be mistaken.

"3. Give dimensions of sheds, privies, stables, &c., with their relations to living-rooms.

"5. Examine cellars VERY CAREFULLY, and describe their condition, particularly with regard to dampness, amount and kind of filth, ventilation, &c.

"7. Is there any offensive small from the sinks? Are the pipes or spouts water-tight? Are there any traps to prevent foul air from coming into the rooms? Are the spouts broken, leaky, and filthy? Are the sink-drains clogged or uncovered? Are the cess-pools tightly covered and clean? Do the cess-polls leak into the cellar or into the well?

"8. Privies and vaults: Describe their condition particularly. Are they full or running over? Are they filthy? Is the vault tightly covered? Do they smell badly? Do the vaults need emptying?

"9. Describe particularly the kind and amount of all heaps of filth about the premises, and the general condition of the yards.

"11. Public nuisances, as sewers, stables, offensive manufactories, &c.

"12. Not overcrowding.

"13, 14, 15. Inquire particularly.

"16. State whether, in addition to the supply from water mains, water is used from a well or cistern; whether it is called good or bad; whether any filth probably drains into the well, &c.

"17. Note bedding, wearing apparel, and upholstered furniture, and whether disinfection has been performed in the house.

"Give any other information and make such suggestions as may occur to you on the back of the form, referring, when necessary, to the numbers. Give all descriptions in as few words as possible, but be clear and definite."

It is considered that this form is more convenient for the purposes of such an inspection as the committee desired to make than any form of memorandum-book to be carried in the pocket. It was found that a very excellent contour map for the greater portion of the city had been prepared by Mr. Charles Hermany, the engineer in charge of the water-works at Louisville, Ky., in connection with a report made by him to the city proposing a system of sewerage and water supply in the year 1868, and after examination of this map it was not considered necessary to have any further work done in this direction for the purposes of this survey.

As soon as the epidemic had ceased and a majority of the citizens had returned to their homes, the house-to-house inspection was commenced under the immediate direction of Dr. R. W. Mitchell, the resident member of the Board.

At the close of the meeting of the National Board of Health at Nashville, Tenn., November 22, the committee met in Memphis, having associated with it Maj. W. H. H. Benyaurd, United States Engineers, detailed by the War Department as consulting engineer in accordance with the request of the Board; Dr. C. F. Folsom, secretary of the State Board of Health of Massachusetts; George E. Waring, jr., and Dr. Charles Smart, United States Army, who had been specially detailed for the purpose of making analyses of the water supply.

After a general survey of the city and obtaining information and suggestions from the authorities and principal citizens of the place, and after an examination of the results of so much of the house-to-house inspection as was then completed, the committee prepared a preliminary report, and in view of the urgency of the case and the

PLATE II.

Fig. 1.—This photomicrograph is from the pollen of *Carolinia*, a tree from Guiana. The specimen was brought to me by my friend, Dr. Gustav Devron, of New Orleans, and the photograph is introduced to illustrate the fact that pollen is one of the most common organisms found in the atmosphere, and more especially to show that satisfactory photographs may be made of organisms of this kind. The amplification is 200 diameters.

Fig. 2 is from the surface of a glass slide exposed in a vault in Lafayette Cemetery, New Orleans. These oval spores are believed to belong to a fungus of the genus *Botrytis*. Amplification, 400 diameters.

Fig. 3 is from an aspiration experiment made in front of my laboratory in New Orleans, and represents a mass of decomposing vegetable tissue containing starch granules. × 200 diameters.

Fig. 4.—From surface of glass slide exposed for forty-eight hours in military hospital, Havana, × 400. These crystals are found elsewhere, and their presence in the hospital is believed to have no special significance.

Fig. 5.—Crystals from surface of glass slide exposed for forty-eight hours in military hospital, Havana. × 212 diameters. (See remarks on page ——.)

Fig. 6.—Crystals from surface of watch-glass exposed in open air, Morgan City, La., 1879. × 300 diameters. (See remarks on page ——.)

Fig. 7.—Pollen of pine and spores of fungus, common in the atmosphere of New Orleans during the spring months. × 200 diameters.

Fig. 8.—Spores of *Penicillium glaucum*, common everywhere. × 400 diameters.

Fig. 9.—Scales from body of a mosquito, common in the atmosphere of New Orleans and elsewhere. × 200 diameters.

APPENDIX I.

PATHOLOGICAL HISTOLOGY OF YELLOW FEVER.

BY J. J. WOODWARD, *Surgeon U. S. A.*

The following remarks on the pathological histology of yellow fever were prepared at the request of the National Board of Health, and submitted by Dr. Woodward April 6, 1881.

ARMY MEDICAL MUSEUM, *April 6, 1880.*

Dr. JAMES L. CABELL,
President of the National Board of Health:

DEAR SIR: November 4, 1879, I had the honor to receive a letter from the secretary, requesting me, in the name of the National Board of Health, to examine a number of pathological specimens from subjects dead of yellow fever, collected by the commission sent to Havana during the previous summer. I was asked in case the specimens proved to be of such character and in such a state of preservation as to permit it, to "prepare a report on the pathology of yellow fever," to be published with the reports of the Havana commission, or, as an alternative, at least to "indicate the direction in which research is most needed and is most likely to prove of value." At a subsequent period I received from the secretary of the Board a number of permanently mounted microscopic slides prepared by Dr. J. Guiteras, one of the members of the commission, from specimens collected at the same time as those sent me.

I replied to the letter of November 4 that I was ready to comply with the wishes of the Board to the extent of my power; and accordingly, since that time, I have not only made a microscopical investigation of the pathological pieces sent me, so far as their condition permitted, and examined with care the mounted preparations of Dr. Guiteras, but have studied the most important recent contributions to the pathological anatomy of this disease, in order to acquaint myself as fully as possible with the present state of knowledge on the question at issue.

I regret to say that the pathological pieces sent me were not in a condition for very satisfactory study, the autopsies having been performed too long after death (5 to 18 hours). We have the testimony of a number of trustworthy observers that cadaveric changes occur much more rapidly after death from yellow fever than after death from ordinary non-malignant acute diseases, so that the period mentioned, which in the tropical climate of Havana during July and August would be, I should suppose, quite sufficient to impair the value for refined histological researches of the normal tissues of those dead by violence, might be expected to give rise to still more serious changes in those dead of yellow fever. To this cause also, in part, I attribute the circumstance

viding that no buildings shall be hereafter erected in the city unless the plans have been approved by the sanitary authority, and that the construction shall also be subject to its inspection and approval. All uncondemned buildings whose lower floors are less than two feet from the ground should be raised to that height as early as possible, and in future all dwellings should be built with their lower floors at least two feet from the ground; also, that all cellars and basements should be freely ventilated. All this should be enforced by municipal authority.

Eighth. In this brief report no recommendations are made with regard to many important points in municipal sanitation, such as the system of removal of garbage, slop-water, dead animals, and refuse; the regulation of markets and slaughter-houses, hospitals and public charities, public baths, cemeteries, school-houses, &c.—in part because the detailed inspections on these points are not yet completed, in part because these are largely matters of detail, requiring the constant supervision of the competent sanitary authority, urged in our first recommendation; and the providing such authority is the best means of insuring that all these things will receive due attention. The existing regulations requiring the reporting of all cases of contagious and infectious disease, and also the requiring of burial permits, should be strictly enforced.

Ninth. With the exception of those devoted to heavy traffic, it is advised that all streets should be constructed of Paducah gravel, laid on a properly-shaped road-bed, after the subsoil drains have been established, and that the gutters and curbs should be made of concrete.

Since the visit of the committee, Dr. F. W. Reilly, who had been appointed inspector in charge and assumed the duties of that position November 22, has, in accordance with the instructions of the committee, vigorously pushed the house-to-house inspection, and this was completed early in January.

A copy of Dr. Reilly's report and a summary of the sanitary history of Memphis, Tenn., prepared by him is herewith submitted.

In connection with this there is also submitted a report of Dr. Charles Smart, U. S. A., on the analyses of the water supply of certain towns of Mississippi and Tennessee, and more especially of the city of Memphis. It will be seen from these reports that the report of the results of the inspection of one ward of the city, upon which the committee based the recommendations contained in their preliminary report of November 27, gave a fair sample of the condition of the entire place, and it is not probable that the recommendations of the committee would have been materially different in any respect had they had at that time the entire data which are now presented. As the house-to-house inspection proceeded, Dr. Reilly, in accordance with the instruction of the committee, has furnished to the authorities of the city lists of the principal nuisances discovered, giving their precise location and character.

The recommendations contained in the preliminary report of the committee were approved by the executive authorities and by the committee of citizens of Memphis, who petitioned the governor to call a special session of the legislature to grant to the taxing district the necessary authority to levy a tax to carry out the work thus recommended.

Accordingly the legislature was called and passed an act authorizing the levying of a tax of two per cent., one-half to be collected in February and one-half in November.

In the mean time the legislative council had passed an ordinance directing the immediate emptying and filling up with fresh earth of all privy vaults in the city. This met with considerable opposition, and the result was that the ordinance was finally modified to read as follows:

"SECTION 1. *Be it ordained by the legislative council,* That so much of the health ordinances, sections 258*a* to 258*e*, inclusive, p. 1245 (Heiskell's Digest), as require the filling up of all privy vaults, and the carrying away of excrement at the occupant's or owner's expense, be, and the same is hereby, modified, and shall have force as follows: There shall be appointed by this council and the board of health, inspectors of vaults, who shall each at once proceed to inspect every privy vault and water-closet in the respective districts assigned them, and where in his or their opinion the same, or any of them, are in unsanitary condition, the inspector shall at once condemn the same as a nuisance, and notify the occupant or owner of the premises, where such privy vault or water-closet is, to clean out, disinfect, and fill up the same within ten days thereafter: *Provided, however,* When such occupant or owner is so notified, if he feels aggrieved by such action, he may petition the fire and police commissioners, within two days after said notice, to have a committee of three citizens, to be appointed by the president, to visit and inspect such vault, who shall act at once, and upon their inspection such action shall be taken as they or any two of them may in writing suggest.

"SEC. 2. *Be it further ordained,* That after the privy vaults have been cleaned out, disinfected, and filled up, the fecal matter from receptacles provided therefor shall be removed at the expense of the district until connections can be made with the sewers now in contemplation of construction, or until such time as this council shall further determine; and receptacles shall be furnished by the district to all who choose to accept the same, at the lowest cost price.

"The object of this modification being to more effectually and certainly prevent the pollution of soil, air, or water, and carry out the recommendations of the National Board of Health.

"Passed January 10, 1880.

"D. T. PORTER,
"*President.*

"C. L. PULLEN,
"*Secretary.*"

The plan of sewerage proposed by Colonel Waring was finally adopted by the legislative council, and in the latter part of January contracts were made for sewer-pipe and Colonel Waring was appointed to superintend the work, which at the present time is going on as fast as the nature of the case will admit. It is hoped that the principal portions of the city will have sewer connections by the 1st of May next. The work of condemning and destroying unsanitary houses, shanties, &c., has been going on in accordance with the necessary legal forms, and over one hundred such houses have been destroyed at the present time.

In addition to those that are to be destroyed there are a large number of houses in Memphis which ought to be raised from the ground, so as to permit the free circulation of air beneath them.

The quantity of dangerously infected material, bedding, clothing, &c., now in the city of Memphis which has not been disinfected is probably small. In a majority of houses in which the disease occurred during the past year articles of infected clothing or bedding were either destroyed or disinfected at the time, and the location of the remainder has been pointed out in detail to the health authorities. The committee have also strongly urged on the authorities from time to time the destruction of collections of rags, of which there are several in junk-shops in Memphis. One of the largest of these collections was burned by an accidental fire in the fall of the year. While it is quite possible that during the cold weather these rags might be baled and sent to paper-mills in the North and be there used with impunity, it is well known that the stock received at paper-mills is often not used for a number of months and that thus there is certainly at least a possibility of conveying the disease in this way. Irrespective of this, however, it is believed that the general principle of forbidding the exportation of rags of any kind, from a place so dangerously infected as Memphis has been, is one that should be maintained, and that to secure the confidence of neighboring communities all such collections should be forbidden, and if found should be promptly destroyed. It is impossible to secure satisfactory evidence that the whole of any given quantity of rags has been properly disinfected, and the value of such collections is not sufficient to warrant attempts at their preservation.

Owing to the delays in obtaining the necessary authority from the legislature deciding upon the plan for sewerage, making the necessary contracts, &c., it will be impossible to commence the work of laying the sewers at the point where it is desirable that this should be done, viz, at the lowest point on the level opening into the river, since the river is now many feet above low-water mark, and extensive back-water is caused in the Bayou Gayoso. To avoid the difficulty which this would cause it is proposed temporarily to turn the sewage into a large iron pipe at present used for carrying the sewage from the prison into the river.

It is hoped that much will be done before the approach of warm weather in the way of destruction of infected material and houses, of cleaning and filling the worst of the privy vaults, in establishing a system of sewerage, and to some extent a system of drainage throughout the city. Very little, however, can be done during the present season to remedy the evils of the present water supply. The difficulty and cost of extending by means of inverted siphons the supply pipe for the present water-works across the Wolf and Hatchie Rivers to the Mississippi River is so great that the parties now having control of the water-works will not attempt it. The majority of the cisterns in the town contain water which is unfit for use, at least without boiling; and the water from the Wolf River is unfit for use without careful filtration, by means of filters which should be very frequently renewed.

The report of Dr. Reilly, and especially the statistics of the mortality of the city with his remarks thereon, furnish additional proof, if any were needed, as to the unsanitary conditions which have prevailed.

The following communication was addressed to President D. T. Porter, under date of February 16, 1880:

"DEAR SIR: I have the honor to invite your attention to the fact that it will be prudent for the municipal authorities of Memphis to keep in view the possibility of the reappearance of yellow fever in that city as warm weather comes on, somewhat as the disease appeared last year. While we have good reason to hope that the sanitary measures which have been inaugurated, and are now being urged, by the city may have the effect to free the place of local causes of this disease, it is still impossible at the present time to say with certainty that this will be completely effected.

This uncertainty increases the responsibility of those officially charged with the interests of the city, and makes it imperative that the powers conferred and the duties imposed upon them by law be utilized and discharged to the fullest extent.

"In view of the great desirability of taking every precaution to prevent the recurrence of an epidemic during the coming year, I would respectfully offer the following suggestions, premising that I do this with a full appreciation of the difficulties and drawbacks under which the officers of the taxing district have heretofore labored, but which it is presumed are now in the main removed by the decision affirming the constitutionality of the district government.

"Sections 158 and 259 of article 1, chapter 5, of the ordinances of Shelby County, Tennessee (see pp. 97 and 125–6 of Heiskell's Digest, Memphis, 1879), confer upon the board of health the authority to make, establish, and declare all rules, orders, special regulations, and sanitary ordinances necessary for carrying into effect the provisions and powers contained in said article. And the latter section (259) declares the neglect or violation of any such rules, orders, sanitary regulations or ordinances, to be a misdemeanor, punishable by fine on trial and conviction.

"Under this authority it is clearly the duty of the board of health, as it is certainly of the utmost importance, to 'declare,' by publication in the columns of the daily papers, by circular, and by other, usual methods, the duties and responsibilities of the various classes of the community, professional and secular, with reference to the public health. It is idle to expect that any large number, even of physicians or other intelligent members of the community, will make such study of the ordinances as is necessary to define their duties and responsibilities; but it may be safely asserted that if the requirements were understood they would receive prompt and willing compliance from the large majority of all classes. As early notification of the existence of contagious disease is of the first importance at all times, but more especially at present, I would suggest that the regulations of the board for the enforcement of section 236 (see Digest, p. 118), requiring 'every physician to report to the board of health in writing every person having a contagious disease,' &c., set forth that it shall be held to be a substantial compliance with this section if the physician furnish to the householder or head of the family in which a contagious case may be a written certificate containing the information called for in said section. Regulations, based on section 240 (*ibid.*, p. 119), should then make it a substantial compliance with the requirements of this latter section if the householder or head of the family promptly deliver said certificate to the secretary of the board of health, but in default of the attendance of a physician should still enforce a literal compliance with the section.

"In this, as in all other regulations of the board, the penalties as prescribed in section 259 (*ibid.*, pp. 125–6) should apply to failure of either party, and should be clearly specified and strictly enforced. My reason for making this suggestion is that it is for the benefit of the householders of the city of Memphis, and not for the benefit of physicians, that such reports should be made, and I do not think it just or good policy to undertake to compel physicians to make such reports without giving them adequate compensation. As a matter of fact, all physicians do not make such reports, and at no place in this country has it been found possible to literally enforce such a law. Another reason is the fact, to which I shall again allude, that among the negroes a physician is by no means always called in in case of yellow fever.

"The enforcement of section 240, in the manner indicated, would, however, tend to secure reports even in such cases.

"Like action is suggested with reference to the following sections, if it be true, as I am informed, that these sections are ignored:

"Section 154 (*ibid.*, p. 96), requiring physicians, midwives, and others practicing about the cure of the sick or injured, to be properly registered at the board of health.

"Section 237 (*ibid.*, p. 118), requiring reports of deaths from contagious or infectious diseases within twenty-four hours after their occurrence. (I am informed that under the existing practice a death from a contagious disease might occur on Sunday morning and the board of health would have no official cognizance thereof until the following Saturday evening.)

"Section 251 (*ibid.*, p. 122), forbidding the retention or exposure (as in public funerals of decedents from contagious diseases) of dead bodies to the peril or prejudice of the life or health of others.

"Sections 252, 253 (*ibid.*, p. 122), requiring reports of births, marriages, and deaths.

"In such regulations and orders as the board may profitably publish at the present time concerning the foregoing, it is very desirable to charge those immediately interested, namely, the householder or head of the family, with the duty of communicating directly with the board, as has been already indicated. Wherever the phrase 'contagious disease' occurs in any quoted section of the ordinances, or in circulars, orders, &c., its definition as given in section 154 (cholera, yellow fever, or scarlet fever) should also be set forth, or so much of it as may be necessary to keep clearly before the public mind the object of the requirements. In addition to the necessary declaration of regulations for the enforcement of the above-named sections, and whose

I undertake this work with great modesty, since the disease is one I have never seen, but I have endeavored to make myself acquainted with the best recent observations, and bring to their consideration such general knowledge of pathological histology as I have acquired by studies which now extend over more than a quarter of a century. I hope therefore that the suggestions I am about to present may not be without value to those who may hereafter undertake to investigate the histological lesions of yellow fever.

These suggestions can be most advantageously presented in connection with a brief statement of the principal differences between the accounts of recent observers; for evidently our first step forward must be to endeavor to ascertain by observation which of these discrepant statements is in accordance with facts, or, if in any case none of them fully represent the facts, to ascertain what these actually are. I shall make no attempt at a complete analysis of the very voluminous recent literature, but only refer to what appear to be the most significant original observations.

The histologist who may undertake to study the lesions of yellow fever, will find it necessary to the interpretation of the conditions observed in the dead body to make certain investigations during the progress of the disease at the bedside of the sick.

A.—MICROSCOPICAL INVESTIGATIONS AT THE BEDSIDE OF THE SICK.

These refer especially to the blood, the black vomit, and the urine.

1. *The blood.*—And, first, as to the examination of the blood, which has been regarded by so many physicians as the primary seat of the specific changes produced by the yellow-fever poison, or at least as the vehicle by which the poison is conveyed to the nervous centers or other parts supposed to be the first seat of morbid action. The most important discrepancies between the modern accounts of the pathological histology of the blood in yellow fever refer to the condition of the red and white corpuscles, and to the alleged detection of low vegetable forms, supposed to be related to the causation of the disease.

Can any change be detected with the microscope in the red corpuscles of yellow-fever blood? The old observation of Bienperthuy (1844), who affirmed that even at an early period of the disease "the parenchyma which serves as an envelope to the globules was destroyed," was long ago contradicted by that careful microscopist Prof. Joseph Leidy (1854),* who was unable to discover "the slightest indication of such a process," and reported that in the cases he examined with the microscope "the corpuscles were found apparently unchanged." Yet the opinion that in this disease the red-blood corpuscles in some way break up, and that perhaps the characteristic icterus is due to the "transformation of their hæmatine into bile pigment within the circulation," has continued to find adherents, as may be seen by the article of Haenisch, in Ziemssen's Cyclopædia. Two of our own countrymen, Dr. Joseph Jones and H. D. Schmidt, have recorded observations, made in New Orleans during the epidemic of 1878, which appear to lend some support to this opinion. Dr. Joseph Jones observed that in the blood drawn by cut cups from yellow fever patients, "the colored corpuscles presented a crenated appearance," due to "irregular elevations or exudations of the surface of the corpuscles," or "presented a stellate and granular appearance, as if minute globules were forming upon the surface of the cell membrane."†

Dr. H. D. Schmidt carried his microscope with him into the hospital ward, and took, it would appear, many precautions in order to observe the blood as fresh as possible. He examined the blood of fifteen cases, and in all, "with the exception of two, the colored blood corpuscles presented the crenated form." Dr. Schmidt regards this change as probably "retrogressive in character, indicating a loss of vitality on the part of the blood corpuscles," and, quite in harmony with this view, he recognizes the presence of "hæmoglobulin escaped from the blood" in the granular cells of "the liver and some other organs," and mentions that he observed "free hæmoglobulin" in one of the specimens of blood he examined, although he remarks that this "is a phenomenon sometimes even met with in the examination of normal human blood."

Dr. John Davy (1847) long since observed that when blood taken from the body of a subject dead of yellow fever was examined under the microscope "the corpuscles were seen to be corrugated, as if from incipent putrefaction;" but he did not recognize this condition in blood taken from living patients, nor has it attracted the attention, so far as I know, of any recent observers other than those cited above. Deputy Inspector-General Robert Lawson, writing in 1862 of the yellow fever of Jamaica, remarks: "It seems still a common belief that the blood in yellow fever is in a dis-

*See "La Roche," Vol. I, p. 171. To avoid repetitions, I shall not, as a rule, give references to the authorities cited in this paper, but will append a list of the several books and essays referred to.

†It is to be inferred that these examinations were always made in the manner described in connection with the observation here cited: "I hastened to my laboratory with the blood of the patient, which had been received into glass-stoppered bottles, chemically clean, and which had never been used before, and submitted the blood to microscopical examination." See the first essay of Dr. Jones, cited in the appended list, p. 952.

A commencement of a sanitary history of every house in the city has now been obtained, and a very moderate expenditure will keep this record complete for the future.

There are many other cities in this country which would be greatly improved and profited by such a house-to-house inspection as has been made in Memphis, and it is to be hoped that the citizens and municipal authorities of all our towns and cities will see that it is much wiser to make such an inspection before the epidemic than after it.

Respectfully submitted.

For the committee:

J. S. BILLINGS, M. D.,
Chairman.

Documents accompanying the report of the chairman of the committee on house-to-house inspection at Memphis.

A.

REPORT OF DR. F. W. REILLY.

SIR: In pursuance of instructions from the committee on the sanitary survey of Memphis, received November 21, 1879, charge of the house-to-house inspection of the city was assumed on the following day, November 22. Sufficient preliminary work had already been done to demonstrate the necessity for a material modification of the plan originally proposed, and which contemplated that the inspections should be made by four or five medical gentlemen detailed for that purpose. At the rate of progress prior to November 21 it was evident that the work could not be accomplished in season to be of any practical utility before the advent of warm weather. Therefore, under the authority conveyed in the instructions above mentioned, and which were, in brief, to push the work to completion as rapidly as was consistent with thoroughness and accuracy, and to this end to engage such number of sub-inspectors as could be profitably employed, a force of twenty-six men (subsequently increased) was put into the field on the following Monday, November 24. These were paid at the rate of two dollars per day for each day of actual services, and worked in ward squads, each ward under the immediate charge of a sanitary inspector detailed by the National Board of Health for that purpose. These men were furnished with fifty-foot measuring tapes, two-foot rules, lanterns and indellible pencils, and printed forms for returns. In addition to the direct supervision of the inspector, the daily returns of each squad were required to be revised and indorsed by that officer before forwarding to this office, thus making each inspector personally responsible for the correctness of the work of his subordinates.

Some difficulty was at first encountered in securing competent men for subinspectors and in teaching these the distinction between facts and opinions, and much time was consumed in correcting faulty returns during the first week or two; but a steady improvement was manifested, both in quality and quantity, as the work progressed.

In addition to the supervision of their respective squads each inspector was required to personally examine and report upon the special sanitary features of the ward under his charge, and to call attention at once to the graver nuisances and conditions needing immediate action.

Field work was completed on January 3, 1880, having occupied thirty-four working days, on fourteen of which rain fell in sufficient quantity to seriously interfere with inspections. (During the period the total rainfall amounted to 14.52 inches.)

The office work embraced, in addition to the tabulation of the inspection returns and the strictly clerical routine duties, the preparation of various special reports (on the public schools, the river front, condition of the bayous, condemnation of buildings, infected material, garbage removal, &c.), which were submitted from time to time to the local authorities through the resident member of the committee, Dr. R. W. Mitchell, National Board of Health.

A schedule of the conditions requiring attention from the local authorities was also compiled for each ward as soon as its inspection was completed and this was transmitted, through the same channel, to the authorities of the taxing district. Ten of these schedules were thus prepared, covering 256 pages of legal cap paper in six columns, and setting forth the location and description of 12,390 insanitary conditions of all grades.

Ninety-six folio volumes of inspection returns, covering 9,508 inspections, have been paginated, indexed, and grouped by wards in such a manner as to make instant reference to the original inspection of any locality possible. The tabulation of the returns fills four royal folio volumes, containing 176,433 different entries. On these sheets it is believed every structure and individual lot of ground within the corporate limits of Memphis is succinctly described, with its sanitary history at the date of inspection.

Data have also been furnished from this office to Major Benyuard, United States Engineer Corps, from which has been compiled a map showing the ownership, area, and estimated value of the property abutting upon the bayou. (This is intended to further the plan for the bayou conservancy, recommended by the committee on the sanitary survey.)

A sanitary ward map, indicating, by colors, condemned buildings, infected material, yellow-fever localities of 1878-'79, foul vaults, polluted and suspicious water supply, and public nuisances, has also been prepared, and such a map of the entire city is now being completed. These subjects are so designated that ready reference may be made to the original inspection return for a full description of any individual locality.

During the progress of the work the following gentlemen have been engaged as inspectors, by authority of the National Board of Health:

Dr. G. D. Bradford (Memphis), from November 7 to December 31.
Dr. S. H. Collins (Memphis), from November 7; still on duty.
Dr. H. Ess (Memphis), from November 7 to November 24.
Dr. P. B. McCutcheon (New Orleans), from November 28 to December 31.
Dr. G. W. Overall (Memphis), from November 24 to December 15.
Dr. F. W. Parham (New Orleans), from November 28 to December 31.
Dr. W. B. Winn (Memphis), from November 7 to December 31.

Accompanying this letter is a general outline of the sanitary history of the city, based in great part upon the results of the house-to-house inspection, and covering, it is believed, most of the topics of general interest.

I am, sir, very respectfully, your obedient servant,

F. W. REILLY, M. D.,
Inspector-in-Charge.

JOHN S. BILLINGS, M. D., U. S. A.,
Chairman Committee on Sanitary Survey of Memphis.

Summary sanitary history of Memphis, Tenn., based upon a house-to-house inspection of the city, November 24, 1879, to January 3, 1880, made under the direction of the National Board of Health.

The city of Memphis, at present the "taxing district of Shelby County," is situated in Shelby County, Tennessee, latitude 35° 7′ north, longitude 90° 7′ west, with a greatest altitude of 287.44 feet above tide-water in the Gulf of Mexico.

As early as 1682 the site of the present city was occupied as a trading post by the French under La Salle, who made a treaty with the Indians of the Chickasaw tribe, and built a fort upon the bluff, which bears their name. In 1783 the region was taken possession of by the Spanish governor-general of Louisiana, Don Gayoso, whose name is also perpetuated in the bayou running through the city. Gayoso fortified the post at the then mouth of the Wolf River, about where the foot of Jefferson street now is, and the Spanish occupation continued until the treaty of San Ildefonso, in 1803.

The original purchase of the five thousand acres in which the site is included was made in 1783, by John Rice, a merchant who removed from North Carolina to Nashville about this period. In 1794 Judge John Overton became the owner of the tract, and conveyed a half interest in the property to General Andrew Jackson, who in turn sold three-fourths of his interest to James and William Winchester, in the year 1819. In the following year, 1820, the town was planned, and called Memphis. At this time the settlement numbered fifty-three souls. In 1826 the town, with a population of between five and six hundred, was incorporated; but, owing to local rivalries, two corporations, the "city of Memphis" and the "city of South Memphis," were erected under the charter, and so continued until 1852, when they united in the election of one mayor and one board of aldermen.

POPULATION AND GROWTH.

At this time the population was estimated at less than 10,000, a rapid advance being claimed for the two subsequent years, so that in 1854 a census showed 12,867 inhabitants, which was increased by the close of 1857 to an estimated population of 25,000, this rapid growth being attributed to the completion of the first portion of the Memphis and Charleston Railroad. Although there was a large increase between 1850 and 1860, this latter estimate was not borne out by the figures of the eighth United States census, which gave Memphis a population in 1860 of 22,621, as against 8,841 in 1850, by the same authority. The ninth census (1870) placed the population at 40,226; but it is important to note in this connection that the city limits were materially enlarged in 1867-'68, so much so that they embraced 4,114 acres at the time when the ninth census was taken; and much of this additional area was as thickly settled as the average of the former or present area. During the session of the State legislature of 1871

and 1872 another change was made, and the area was reduced to the present city limits, a reduction which cut off 37 + per cent. of territory and 39 + per cent. of population. This would make the population of 1870, contained within the area of the present city limits, 24,253, and it is this figure, and not 40,226, which should be taken in any estimate of the growth of the city within the past decade.

PRESENT POPULATION.

On the 1st of January, 1880, the population of Memphis, as shown by the house-to-house inspection returns, is 30,659, showing an increase of nearly 26.4 per cent. since 1870. Of these there are 16,705 whites in 3,775 families, an average of 4.42 persons to each family, and 13,954 colored in 3,609 families, an average of 3.87 persons to each family, a mean average of 4.15 persons to the aggregate of 7,384 families. These occupy 5,584 of the 6,386 dwellings accounted for, giving an average of 5.49 persons to each occupied dwelling. In 1870 there were 5.14 persons to each family (white and colored not separated), and 6.28 persons to each dwelling. The reduced average of occupants to dwellings is readily enough accounted for by the large number of buildings erected during the decade, an increase equal to nearly 54 per cent., while the increase of population is, as above shown, less than 27 per cent. An explanation of the reduction in the number of persons to a family is more difficult, and is complicated with questions involving a study of the epidemics of 1873, 1878, and 1879, of the changed social status of the colored people, and other factors not, probably, beyond the scope of a "sanitary survey," but for which no opportunity has yet offered.*

AREA AND TOPOGRAPHY.

An area of 2,590 acres is embraced within the present city limits, the outlines of which approximate the figure of a truncated right-angle triangle (or trapezoid), the truncated extremity (8,175 feet) being the northern boundary; the perpendicular (13,050 feet) the east boundary; the base (11,625 feet) the southern boundary; while the hypothenuse (17,000 feet) is the water frontage on the Mississippi River.†

The site of Memphis and the country immediately surrounding it is the Fourth Chickasaw Bluff, a Loess formation, consisting of a fine siliceous loam, of a rich chrome yellow or buff color. This is superimposed upon a varicolored stratum of sands and gravel, locally known as the "orange sand," a southern extension of the drift formation, and immediately beneath which is found the La Grange group of clays

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* This percentage of reduction of population is reached by the following process:

Within the city limits of 1870 there were 6,408 dwellings, with an average of nearly 6.28 persons (6.2774+) to each. There are in the present city limits 6,386 dwellings, of which number 2,524 are returned as ten years and under. Deducting these latter from the total present number leaves 3,862 dwellings, which in 1870 were within the present city limits, and as a consequence 2,546 in the area since cut off. Multiplying these 3,862 by 6.28, the average number of persons in each dwelling at that time, gives 24,253 as the figure of population with which to compare the present population. The exact figures would be $3,862 \times 6.2774 = 24,243.31$ population in 1870 within area of present city limits, and $2,546 \times 6.2774 = 15,982.26$ population in area cut off in 1871–'72.

If it be sought to compare the population of 1870 (40,226) with that of 1880, it will be necessary to assume the same ratio of increase for the area cut off in 1871–'72, as is known to have been made within the present city limits. This is 26.4 per cent., and would give a total present population of 50,485 within the same area as that occupied, according to the ninth census, by 40,226 persons in 1870.

† In order to arrive at the percentage of error in these figures—both that of the "personal equation" and that due to the movement of population—an experimental census of 5 per cent. of dwellings was taken on January 14, 1880. This was done by assigning to each of four men a certain number of dwellings in each ward, the number being distributed pro rata to the total number in each ward. The houses were not designated in advance, but their selection was left to the discretion of the men, care only being taken that the houses should represent all portions of the ward. When these returns were brought in they were entered upon sheets, the first column of which contained the location by street and number of each house visited; the next two columns gave the numbers of white and colored occupants, respectively, found in each house on the 14th of January. The totals of these latter columns were then footed up, and, lastly, the original inspection returns of these same houses were consulted, and in the two remaining columns the numbers of white and colored occupants during November and December were entered. On footing up these columns there was found a difference of only *two* between the total occupants of the same houses on January 14 and in November and December. That is to say, in 286 occupied dwellings taken at random on January 14, there were found 1,533 persons; on comparison, these dwellings were found to have had returned, by a different set of inspectors during the previous November and December, a total of 1,535 persons.

This striking coincidence need not, however, be accepted as conclusive of the accuracy of the grand total, since an analysis of the returns by wards shows a much greater movement than is here indicated. Thus in the fourth ward, which is the hotel and business center, there was a gain of 36 whites and 2 colored, while in the first and sixth wards—frequented by rivermen—there was a loss of 30 colored, the total movement showing a gain of 38 white persons and a loss of 40 colored. This was exactly the reverse of the anticipated result. It was believed that a considerable number of colored people properly belonging to Memphis were absent in the cotton-fields in November and December; that these would return about the holiday season, and thus increase the proportion of colored in the experimental census. On the other hand it had been asserted that many white refugees who returned in November and December had wound up their business and affairs in the city and removed permanently to other places; a decrease in the proportion of the white population was therefore looked for in January. Under the circumstances, the adoption of any given percentage of error in the house-to-house census must be purely a matter of individual opinion, since none is revealed by the experimental census.

and sands of the Tertiary period. The "orange sand" stratum is nearly horizontal, so that it is reached at varying depths, according to the thickness of the loam above it.

The bluff formation is well defined along the southern half or two-thirds of the river front of the city, where it presents a bold, almost perpendicular western face, cut through by street openings to the levee. Its greatest elevation is in the southwestern section (on Tennessee street, near the corner of Talbot), where it rises to a height of 67.9 feet above the highest water mark, that of 1867. From this point, along the river front, it gradually descends towards the north, until it is lost in the valley of Bayou Gayoso, some 1,500 feet south of the north boundary. Toward the south the inclination is much less, so that at the south boundary near the river the highest bluff level is still 57 feet above high water. North of Bayou Gayoso the bluff again rises, but recedes from the river at a much greater angle. Extending back (east) from the river the surface is undulating, with the long axes of the swells and depressions in general north and south lines, except in the northern portion ("Chelsea," "Scotland," and the upper part of "The Pinch"), where the long axes run nearly east and west.

NATURAL DRAINAGE SYSTEM.

Through the depressions flow a series of bayous which form the natural drains of the area, only a narrow strip along the river front draining into the Mississippi River, except in the extreme northwestern portion of the city. Of these bayous, the Gayoso and Quimby are the most important. Bayou Gayoso (with its east and west forks and its tributaries, the Little Betty and De Soto) drains the southern and central divisions of the city, and flows in a general northerly direction until it receives Bayou Quimby with the drainage of the northern division, when it pursues a northwest and west course, emptying into the Wolf River at a point about 2,500 feet above the junction of the latter stream with the Mississippi.

This natural drainage, flowing mainly from south to north, is still further supplemented by minor undulations running at nearly right angles with the above. As the original conformation of the site has not been materially changed, these undulations afford lateral drainage communicating with the main system, and with the exception of the localities to be hereafter specified, this surface drainage is ample, even for the heaviest rain-falls.

The average width of the bayous within the city limits varies from ten to twenty-five feet, measured at about mid-height of the banks, and the volume of water varies with the rain-fall and stage of water in the Mississippi.

There are but few springs emptying into the bayous, so that their contained water is mainly made up of the surface drainage, and of what is locally known as "sipe" water—water which has penetrated below the surface, and gradually oozed out through the banks of the bayous. During high water in the Mississippi, the river water enters the bayous and "backs up" the contents of the latter, this "backing up" having been known to extend for over a mile through the most densely settled parts of the city, and leaving behind it, in the bed of the lower part of the bayou, accumulations of mud or silt of five or six feet in depth. As the stage of water in the river is high enough to obstruct the bayou for four or five months in the year, the current is sufficiently retarded during that period to allow of a large deposit of organic matter upon the banks of the bayous, which rapidly decomposes and becomes offensive as the water falls and exposes it to the action of sun and air. In addition to this source of pollution, there are a large number of privies, built directly over the bayous or upon their banks, the contents of which are discharged directly into the waters, while the surface and sipe water, for a distance of several hundred feet in many localities, is also contaminated with fecal filth from surface privies, overflowing and leaky vaults, &c. A five-foot sewer, which gathers the surface drainage of an area of some 140 acres, on which is the city hospital, and several small private sewers, also contribute their quota to the fouling of Bayou Gayoso.

Including the city, an area of upward of 5,000 acres is drained by the bayou system; the total length of Bayou Gayoso, from Wolf River to its head, being 5¼ miles, with an inclination of 1 foot in 180 in the city limits; the total length of Bayou Quimby, from its junction with Bayou Gayoso to its head, is a little less than 4¼ miles, with an inclination of about 1 foot in 140; and the total length of Bayou De Soto, from its junction with Bayou Gayoso to its head, is 2½ miles, with a slightly greater inclination than that of Bayou Quimby.

RIVERS—THE WOLF AND MISSISSIPPI.

Wolf River enters the city in the extreme northwestern section, constituting practically its northwestern boundary for an extent of about 4,000 feet.* It is an exceed-

*In the northwestern portion of the city a section of low alluvial land about 300 acres in extent is separated from the first and ninth wards by the Wolf River. This is subject to overflow during high-water, is partly cultivated in cotton, has one white and twelve or fourteen colored families (who are obliged to vacate during high water), and possesses no features of sanitary interest apart from those which characterize the Mississippi "bottom" generally.

ingly tortuous stream, flowing through cypress swamps and cane-brakes for about 65 miles, and receives the Loosa Hatchie River just at the northern boundary of the city. Like the bayous, it is "backed up" when the Mississippi rises more than 15 feet above low-water mark, and it is asserted that at such times the foul waters of the bayou also enter and pollute it. A tannery and a group of slaughter-houses, located about 300 yards below the water-works, discharge blood, offal, and refuse into the stream through a small "run," upon whose banks they are built. It is also stated that when this "backing up" occurs such material is necessarily carried up to the pumps. Aside from its malarial influence, derived from the "bottom" lands through which it flows, the chief sanitary importance of the Wolf consists in its being, to a large extent, the source of the water supply of the city as above intimated. Its waters have been analyzed by Assistant Surgeon Smart, U. S. A., and detailed information concerning it will be found in his report upon the water supply of Memphis.

It should be added, however, that personal observation does not confirm the statements made as to the pollution of the water supply by the "backing up" of the bayou and river. With a stage of about 21 feet of water in the Mississippi, and while the bayou was still "backed up," a decided outer current was found in the Wolf opposite the water-works. It is obvious that any rise in the Mississippi sufficient to dam up the waters of Wolf River would also dam up the contents of the bayous and of the "run" above alluded to; and that as the water falls the outward current in the Wolf will be re-established, carrying out with it the retained contents of the bayous and "run." The contents of these latter can only be carried up Wolf River to the water-works when to a suitable stage of water in the Mississippi shall be added a local rain (confined to the watershed of the bayous) heavy enough to swell the volume of water discharged by the bayou beyond the volume of water contained in the Wolf, and sufficiently greater to overcome the fall in the latter stream from the water-works to the mouth of the bayou. Remote as such a coincidence would seem to be, it is stated to have occurred twice within the past ten years. There is, however, reason for believing, from personal observation, that the surface water of the Wolf may be carried up stream for a considerable distance, even when the deeper water is flowing out. Whether this ever occurs to such an extent as to carry the foul waters of the bayou and "run" up to the pumps it is not presumed to assert.

The extreme range between high and low water in the Mississippi at Memphis is about 35 feet, and a gradually shelving shore of varying extent is thus alternately covered and exposed. At the date of inspection, December 16, 1879, with a stage of 19 feet 10 inches above low-water mark, this shore had a greatest width of 258 feet from the foot of the bluff at Jefferson street. Extending north from Jefferson street to the mouth of Wolf River (2,687 feet measured from center of Jefferson to center of Jackson street, along the line of Front Row) the water covered this sloping shore to the foot of the bluff, with the exceptions noted in the reports of a special inspection of the river front (*q. v.*). Extending south from Jefferson street the bluff has been cut away so as to increase the depth of the shore, and this space, known as the "levee," had a varying exposure of from 150 to 260 feet between the water's edge and the foot of the bluff until the line of Beale street was reached (nearly the same distance as that described above). At Beale street the water again came up to the foot of the bluff, but from this point south to the city limits there was an irregular width of from 20 to 200 feet.

THE WATER FRONT.

These three divisions of the river front present strongly marked contrasts. The northern one, beginning at Wolf River, has a low flat area of about four acres ("Happy Hollow") partially submerged during high water, and receiving a considerable portion of the filthy surface drainage of the northern end of the "Pinch," one of the most objectionable quarters of the city, as well as the polluted discharge from the bayou. The bank is sandy and easily washed, so that mattress protection is necessary. From Market street south to Jefferson the bluffs gradually rise, varying in height from 4 to 25 feet, and along this extent are gullies, "wash-outs," deposits of fecal filth, the outlets of box-drains and culverts, and the accumulations of a public "dump," including everything offensive, from street sweepings to the contents of privy vaults, which, up to May, 1879, were carted to the crest of the bluff at the foot of Washington street, and thence allowed to find their own way to the river. The central division consists of the "levee," so called, an improved area paved with stone, clean and in good condition, with the exception of such nuisances as arise from the want of public latrines for the use of the roustabouts, stevedores, rivermen, &c. As the river falls after high water a deposit of mud covers the "levee," but this is washed from the well-paved and steep slope by the first rain. The southern division reproduces many of the evils of the northern one, aggravated by the location of the present public "dump-boat" at the foot of Beale street, a decided nuisance at this date.

The details of the conditions above generalized are embraced in the special report previously alluded to, the substance of which was conveyed to the proper authorities through the committee on the sanitary survey on the 18th of December, 1879, supple-

menting previous reports on some of the conditions which had been already submitted on November 10 and December 13.

SEWERAGE.

There is practically no sewer system in Memphis, the four and a half miles of existing private sewers having only 215 connections in all. And while the natural facilities for surface drainage are ample they have not only not been fully utilized or preserved, but in many instances they have been materially impaired, and in some entirely destroyed, by changes in the original conformation or by the character of the street conservancy. With an extremely retentive soil this obstruction of natural drainage renders unpaved streets and alleys almost impassable during wet weather, and readily accounts for the large proportion of damp or wet cellars and basements. These causes—namely, the absence of sewers and of subsoil drains and the obstructed surface drainage—also affect unfavorably the areas of "made land," although these are not numerous or extensive. (Such areas are described in the summary description of the wards.)

STREETS AND ALLEYS.

There are 67 miles of streets and 35 miles of alleys within the city limits. West of the bayou these run nearly with the cardinal points of the compass, the variation being a little east of north and south of east. In the northeastern section this variation is more decided, but in the central and southern sections the same general lines are preserved on both sides the bayou. Details as to width, paving, and condition of streets, alleys, and sidewalks will be found in the ward summaries.

STREET CLEANING AND GARBAGE REMOVAL.

An ordinance requires tenants to clean the gutters and sweep streets and alleys, bounding their premises, for a space of four feet from curbstone, and to pile up the cleansings in the center of street or alley for the garbage carts—this to be done twice a week, the days for each ward or street to be designated by the board of health. The city engineer is empowered to have such work done for delinquents and non-residents at their proper cost; and street railroads and other railroads are required to clean the roadway between, and for two feet on each side, their tracks. Street crossings and intersections are supposed to be kept clean, and street-sweepings to be removed, by the city.

At the date of this report the equipment for garbage removal and street cleaning consists of 2 open wagons, 44 cubic feet capacity; 4 open "Roosa" carts, 32 cubic feet capacity—these for the removal of ashes, street-sweepings, &c.; 2 Louisville air-tight wagons, 52 cubic feet capacity; 1 "Roosa" air-tight cart, 32 cubic feet capacity—these for the removal of wet garbage, &c.; and 16 men and 13 mules.

Theoretically these are supposed to remove six loads each per day—equal to 1,344 cubic feet of dry, and 816 cubic feet of wet garbage—an average distance, including trips both ways, of one and one-half miles to the "dump" at foot of Beale street; and, also in theory, this is supposed to cover 67 miles of streets and 35 miles of alleys, once each week.

Practically the area west of the bayou, south of Auction street and north of Calhoun street—about two miles long by half a mile wide, and comprising the larger part of the first, all of the second, third, and fourth wards, and much of the sixth ward—is fairly well covered once a week by this force. Much complaint, however, is made of neglect, even in this limited region, and no pretense is made of going into the unpaved streets and alleys in wet weather—in fact, it would be hardly possible to do so. At long intervals, in response to urgent demands, a cart is sent into "Chelsea" (ninth ward); but the fifth, seventh, eighth, and tenth wards, *i. e.*, the region east of the bayou, are substantially ignored, and garbage is here disposed of in every conceivable way—thrown on vacant lots, in alleys in rear of premises, in yards, in disused cisterns and wells, in abandoned privy vaults and gullies, and on the banks of the bayous.

Instead of an average of 54 loads per day being gathered and disposed of (as is believed and stated by the health officer), inquiry at the "dump" and an examination of the dump-keeper's book for a recent period of ten days show an average of 29.2 loads per day—a little more than half the theoretical capacity of the force and equipment. The health officer thinks he should have his force increased at least one-third to thoroughly and promptly remove the garbage from the area west of the bayou, and is unwilling to make an estimate of the force necessary to cover the rest of the city.

No marked or radical improvement is to be looked for in this direction until roadways practicable at all seasons are provided; but much relief might be secured (1) by taking advantage of favorable weather, during which the force should be temporarily increased to the necessary capacity; and (2) by vigorously enforcing the ordinance above referred to, such enforcement to be pushed *pari passu* with the capacity for prompt removal.

BUILDINGS—MATERIAL, AGE, AND CHARACTER.

Of the 7,202 buildings of all kinds (this is exclusive of out-houses) within the city limits, 72 per cent. are of wood, 27 per cent. of brick, and the remainder of stone (13) and iron (1). In the strictly residence portions of the city—in fact, in all but the third and fourth wards—the large majority of the buildings are of one story, there being (with the exceptions above noted) 4,188 dwellings of one story, as against 2,198 of two or more stories. Many of the structures returned as "occupied dwellings" are, in effect, the cabins of one or two rooms which, prior to 1861–'62, constituted the slave-servants' quarters. Of these (one or two roomed dwellings) there are 1,209 returned; and this item is of consequence in connection with the remarks which follow concerning the condemnation of buildings.

About 10 per cent. of the total number of all buildings have been erected within the past five years, and nearly one-fourth of the total number were erected between 1870 and 1875. These buildings, 2,524 in number, embrace the large majority of the really healthy habitations, and substantial, well-ventilated, and properly lighted business blocks. A large number of buildings erected between 1865 and 1870 are mere shells, with thin, insecure walls, flimsy and badly fitting wood-work, and inadequate ventilation and lighting. There are few exceptions to the indictment of this class. Of the remainder (about 40 per cent. of the total number), the ages range from fifteen to fifty years, and there are few of these which do not require radical alterations in order to justify their retention for occupancy.

One of the most important defects noticeable in dwellings is the want of subventilation, 1,453 dwellings being built so close to the ground as to have no air-space beneath the floor; 2,030 others have insufficient or obstructed subventilation; and only 2,204 (about two-fifths of the total number) comply with the proper requirements in this respect.

CELLARS AND BASEMENTS.

There are 1,515 buildings with cellars and basements, and of these over one-half (786) are badly ventilated, damp, or wet, many with water standing from 2 to 18 inches deep on the floors, and with walls soaked by sipage from the surrounding polluted soil. As very few of these cellars are more than 9 feet deep—fully one-half being between 7 and 8 feet, and about one-fourth being less than 7 feet deep—any general system of sewerage and subsoil drainage will remedy this latter defect.

In the two principal business wards of the city (the third and fourth) more than one-third of the buildings were found to have privy vaults in cellars or basements. Many of these buildings are upwards of twenty years old, and the cellars contain from one to five vaults each, the accumulations of an average of a quarter of a century being imperfectly covered over with ashes or earth. Not infrequently the rain-water cistern, from which water for all purposes is used, was found surrounded by these vaults with the walls almost touching each other. A few instances are to be found in every part of the city; but the majority are grouped where they are likely to do the most harm—in the densely built and oldest regions.

Among the minor subterranean defects found were 426 cellars and basements fouled by accumulations of decomposing organic matter, infected material, &c. (The past tense is here used advisedly, since much of this has been already remedied through the efforts of the board of health, which has caused most of these cellars to be cleansed and whitewashed and the vaults emptied, disinfected, and filled up.)

CONDEMNATION OF BUILDINGS.

In condemning premises as unfit for occupancy, as well as in recommending buildings for destruction, the basis has been, in all cases, purely and simply with reference to their sanitary condition. Neither weather-beaten looks, intrinsic value, wishes of neighbors, nor unverifiable reputation has been given any weight in arriving at a judgment on these points. This explanation is thought to be pertinent in view of the fact that many buildings have recently been condemned for destruction by the local authorities which are not included in that category in the house-to-house inspection. It is not meant to imply by this that the action of the local authorities has been, or is likely to be, too sweeping, or that their action has been based, in any instance, on insufficient grounds. At best only a proportion, greater or less, of the unhealthy habitations will be vacated or destroyed; but it was believed any recommendations to this effect having the authority of the National Board should be supported by the clearest and most positive proofs, and that all doubtful cases might be safely left with those who, from their official positions and local knowledge and influence, are best entitled to exercise a discretion which must entail serious responsibility in questions other than those of a strictly sanitary character.

On the basis above set forth a total of 494 buildings and groups of structures have been recommended for destruction or for vacation pending alterations necessary to fit them for occupancy. These include not only many cheap, almost worthless, one

tion. He concluded, therefore, that in the ordinary course of yellow fever a stage of congestion precedes the fatty degeneration of the organ.

This view, which has been accepted by Bérenger-Féraud and other subsequent writers, is supported by some of the observations of Dr. H. D. Schmidt, who states that in epidemics previous to that of 1878 he has sometimes observed parts of the liver congested, while other parts were fatty, and others even normal. The congestion was usually confined to the interlobular vessels, but he observed the "nutmeg" condition also in a limited number of cases. In the autopsies he made during 1878, however, he invariably found the whole liver fatty, and usually in a high degree. Dr. Schmidt, however, describes certain particulars in which the yellow-fever liver differs from the common fatty liver. Although he made his autopsies quite soon after death (three-quarters of an hour to three or four hours), he noticed that the hepatic cells were stained by carmine and other coloring matters with difficulty, and this he attributes to a "commencing degeneration of their protoplasm"; moreover, he states that he recognized the presen e of extravasated hæmoglobulin, with or without associated bile-pigment, in the hepatic cells, "in the vicinity of the ultimate branches of the blood-vessels" of the organ.

Other observers, both earlier and later than he, have believed they detected with the microscope something more than mere fatty degeneration in the yellow-fever liver. Unfortunately, however, the testimony in this direction is by no means harmonious. Lawson, who recognized fatty degeneration of the liver in a part at least of his cases, held (1862) that there is in yellow fever an active exudation into the parenchyma of the organ, embracing the minute bile-ducts, and closing them to the passage of the bile. He also found the interlobular connective tissue abundant, opaline, and containing more or less exudation and granular matter, while the minute arteries and veins "were covered with closely-set nuclei and granules." With this account may be compared the brief description by Bonnet (published in the work of Bérenger-Féraud) of two microscopic sections of the liver of a patient who died of yellow fever during the epidemic of 1877 in French Guiana. They are said to have exhibited thickening and slight sclerosis of the perivascular connective tissue, while cloudy swelling (tuméfaction troublé) was uniformly associated with the fatty degeneration of the cells of the hepatic lobules. Still more marked were the lesions in the interlobular spaces observed by Lebredo in two livers sent in alcohol from Havana to Paris during the year 1877. Besides a fatty degeneration of the parenchyma of the hepatic lobules, in which the capillaries were collapsed, and contained almost no blood, he found unmistakable evidences of the form of cirrhosis described by Charcot and Gombault under the designation of cirrhose en îlots.* He prudently regarded this cirrhosis as an ancient process, long antedating the fever; but conjectured that certain groups of leucocytes observed in the hypertrophied interlobular connective tissues, especially around the biliary canals, were evidences of an acute process occurring during the fever. In the case reported by Dr. T. E. Satterthwaite somewhat similar lesions were observed. Many of the liver cells were in an advanced stage of fatty degeneration, while others were more granular than normal, and it was with difficulty that any nucleus could be recognized. "There was also a marked increase in the connective tissues of the organ, and in places the separate cells were surrounded by new formed connective tissues, as has been observed in syphilitic cirrhosis. Dr. J. Guiteras, of the Havana commission, found one of the livers he examined affected with cirrhosis, which, however, he regarded as a pre-existing chronic process, holding that the lesion characteristic of the yellow-fever liver is "the so-called parenchymatous inflammation of Virchow. The hepatic cells are in a condition of cloudy swelling." At times, however, they show "evidences of fatty degeneration and pigmentary infiltration." Certain modifications in the connective tissue of the organ accompanied these changes; he thought it swollen, and that it presented some embryonal cells.

By yet another group of observers the hepatic lesion in this disease has been regarded as similar to that which characterizes acute yellow atrophy of the liver, or even as identitical with it. This view was especially insisted on by Liebermeister in his essay on parenchymatous degeneration of the liver, although he admitted that it was by no means established by adequate microscopical observation. These Adolfs Schmidtlein has attempted to supply from studies made in 1865 at Vera Cruz. He states that he found the hepatic cells quite destroyed, and, in this and other particulars declares that the histological changes observed fully corresponded with those described by Liebermeister as occurring in acute yellow atrophy. With this statement may be associated the observations recently reported by Guichet. This military surgeon brought back from Madrid, in 1878, pieces of two yellow-fever livers, which were investigated by M. Sabourin in the laboratory of Professor Charcot.† M. Sabourin reports that

*CHARCOT et GOMBAULT. Contributions à l'étude anatimique des defférentes formes de la cirrhose du foie. Archives de Physiologie, 1876, p. 453.

† A piece from a third liver was presented for examination to the laboratory of Vulpian. Fatty degeneration was recognized, but the piece was in such a state of cadaveric alteration that thorough investigation was impossible.

From the foregoing it will be seen that, exclusive of the mortality from yellow fever the average death-rate of Memphis is 34 per thousand, assuming the average population for the past five years to have been 35,000. On the census of 1879 the total mortality for that year was 51 in the thousand, and exclusive of yellow fever it was 30 in the thousand. The average death-rate from all causes during the three non-epidemic years was 35. Of the total number of deaths during the past five years over 15 per cent. were due to phthisis, pneumonia, and other diseases of the lungs, the excess being fairly attributable to defective subventilation of dwellings and to an undrained, retentive soil. Excremental and malarial diseases caused nearly 57 per cent. of the total, and this excess may be set down as due, in great measure, to soil and water pollution.

Under a reasonably efficient sanitary *régime*, with a good sewerage system and pure water supply, the average death-rate of the city should be reduced to about 20 in the thousand within the next lustrum. Until the social and moral status of the colored population is materially improved, it will probably be too much to expect that the theoretical standard of 17 in the thousand can be attained.

It has been no part of the purpose of this summary to seek for, or to point out, causes other than such as are inherent in the conditions described, nor to fix or distribute responsiblity for such conditions. Either of these lines would involve the recital of a story of civic trials and misfortunes which it would be hard, if not impossible, to parallel. To go back no further than the history of the past twelve months for an illustration: The State had already, at the close of 1878, seized one-third of the realty of the city for delinquent taxes, leaving the owners of the remaining $12,000,000 to shoulder the burden of the expenses of State, county, and city governments. To relieve itself of this impending total confiscation, the corporation, on the 31st day of January, 1879, surrendered its charter under an act of the State legislature, which act created in lieu thereof the taxing district of Shelby County, and under which title it was attempted to administer the affairs of a community still stunned by one of the most terrible epidemics of modern history. New offices and officers, new ordinances and regulations, in short, the entire administrative and executive municipal machinery, had to be created *de novo*, and in the face of weighty doubts as to the constitutionality of a single step that was taken. Did the health authorities attempt the abatement of the most palpable nuisance, straightway the question arose as to the authority and responsibility, and there were not wanting obstructives and demagogues to interpose all manner of difficulties to the abridgment of the inalienable right of the *οι πολλοι* to be as filthy as possible. Struggling and crippled, still some progress was made during the spring and summer. Visiting sanitarians spoke and wrote in terms of warm commendation of the efforts, both public and private, they found being put forth to ward off another epidemic visitation and to redeem the city from its legacy of maladministration. With the first announced case of yellow fever, on the 9th July, all this was forgotten, and as the season wore on and the unrelieved monotony of the tale of deaths and new cases first palled upon and then irritated the public ear, Memphis became the theme for all manner of diatribes and abuse—was used to point the tritest sanitary morals and adorn the stalest hygienic tales, until it seemed as though the Bluff

occupying the bluff near the Mississippi, and mainly north of Market street; over 150 cases in a population of about 700; mortality, 56 recorded deaths. Second epidemic in 1855; confined principally to area south of Union street (South Memphis and Fort Pickering), but followed the bayou on both sides, north and west, to Wolf River; estimated number of cases, 1,250 in a population of about 13,000; mortality, 220 (estimated). Third epidemic in 1867; included area of epidemic of 1855, and extended north and east; estimated number of cases, 2,500 in a population of 36,000; mortality, 500 to 550. Fourth epidemic in 1873; spread pretty generally throughout the city, but more severe in northern portion ("The Pinch," "Chelsea," and eighth ward), and extended east beyond the city limits; estimated number of cases, 7,000 out of a population reduced by flight to between 15,000 and 20,000; mortality, recorded between September 14 and November 9 (last death), 1,244; estimated total mortality from August 10 (first death), upward of 2,000. Fifth epidemic in 1878; no portion of the city or suburbs exempt; number of cases, 17,600 out of a remaining population of 19,500; mortality, 5,150 recorded deaths. Sixth epidemic in 1879; area as general as in 1878, except in localities depopulated by flight or removal to camps; total number of recorded cases between July 9 and November 15 (cases occurred in December), 1,532 out of an estimated remaining population of 18,500, of which number 75 per cent. were "protected" in the sense of having previously had the disease; total recorded mortality, 485. The disease was brought to the city in several other years, but was not communicated to the inhabitants. This was notably the case in 1853, when upward of 80 imported cases were treated in hospital and boarding-houses without any spread.

Cholera.—First appearance in the winter of 1832–'33; number of cases and mortality unknown, but it is described as having been severe and general: Second epidemic in 1835; said to have been between 300 and 400 cases, with a mortality of about 15 per cent.; no data of population at this time, but probably about 2,400. Third epidemic in 1849; estimated number of cases about 1,200 in a population of less than 8,000; particularly severe among river boatmen and the foreign population in "The Pinch"; mortality said to have been about 33 per cent. Fourth epidemic in 1865; about 600 cases, mostly among negroes; mortality unknown; disease most severe along Causey street and vicinity (line of contact of fifth and sixth wards). Fifth epidemic in 1873; about 1,000 cases, with 276 recorded deaths; entire population is said to have been afflicted with choleraic diarrhœa.

In addition to the forgoing, *small-pox* was epidemic in 1835 and in 1873; *influenza* in 1842; *dysentery* in 1845 (local, confined to "The Pinch," about 400 cases, and between 40 and 50 deaths); *jaundice*, *erysipelas*, and *puerperal fever* in 1853; and *dengue* in 1860. Prior to 1850 diarrhœal diseases were excessively prevalent, attributed to use of well and spring water; claimed to have diminished on substitution of cistern water.

City had a monopoly of filth, and every other in the land was a very Dutch kitche in point of cleanliness.

The truth is bad enough, and no attempt has been made to shirk it or to palliate i by its citizens. They are fully alive to the necessities of the situation, and though the have much to learn and more to do, they are proving both apt scholars and earne workers. Whether enough can or will be done to avert another epidemic this season i would be premature to assert.

Some of the important recommendations of the committee on the sanitary surve have been thus far ignored or their execution postponed, whether prudently or not th future will determine. But that a marked improvement of the public health mus result from what is now being done and contemplated is beyond peradventure.*

The following is a general summary of the house-to-house inspection at Memphis Tenn., 1879-'80:

Total number structures and premises inspected		12,09
structures	10,873	
vacant lots	1,218	
cemeteries	5	
Total number structures inspected		10,873
dwellings, including 535 with stores or shops attached	6,386	
out-houses	3,617	
stores and office buildings	648	
churches	51	
halls, theaters, hotels, and public buildings	39	
manufactories, mills, and works	35	
academies and private schools	22	
livery stables and stock-yards	21	
cotton-presses, gins, oil-mills, &c	17	
public schools	11	
public markets and slaughter-houses	6	
hospitals and charities	5	
railroad depots and grounds	5	
fire-engine houses	4	
jail, station, and poor-house	3	
gas and water works	2	
United States Government building	1	
Total number buildings, stores, dwellings, schools, &c., excluding public buildings, &c., as well as out-houses		7,202
of wood	5,223	
brick	1,778	
of wood and brick	187	
stone	13	
iron	1	
under 5 years old	793	
between 5 and 10 years old	1,731	
over 10 years old	4,678	
subventilation good	2,204	
bad	2,030	

* During the progress of the house-to-house inspection much detailed information has been incidentally accumulated, covering to a great extent the field outlined in the schedule of questions suggested by the National Board for the "sanitary survey of a city or town." This information has been embodied in a series of special reports, which include the following subjects:

Gas and lighting.
Markets.
Slaughter-houses.
Public schools.
Hospitals and charities.
Police and prisons.
Fire establishment.
Cemeteries and burials.
Public health laws (including quarantine).

These reports are so concise as to obviate the necessity of making abstracts, but are submitted in detail as a portion of the report; as is also a *résumé* of the house-to-house inspection, in which is embraced the chief point of sanitary interest, arranged by wards for convenience of reference. This is believed to be comprehensive and accurate enough to enable the sanitary authorities to outline much, if not all, of the preliminary work which it will be possible to accomplish during the present season. It is founded upon the details of 9,508 inspections; which details have, in turn, been tabulated on 206 large folio sheets, each of which contains, in single lines, the sanitary history of 50 premises—in the aggregate a total of upwards of 176,000 items. In this tabulation the street numbers are arranged continuously, and by this means every structure and lot within the city limits is believed to be accounted for.

none	1,453	
with cellars	891	
basements	624	
Total number cellars and basements		1,515
6 feet deep or less	342	
7 to 8 feet deep	768	
9 feet deep and over (deepest 20 feet)	405	
ventilation good	1,235	
bad	280	
dry	1,009	
damp or wet	506	
clean	1,089	
foul	426	
Total number of dwellings		6,386
of one story	4,188	
one and one-half stories	145	
two stories	1,741	
three stories	253	
four or more stories	59	
Total number dwellings of one story		4,188
with one room	194	
two rooms	1,015	
three or more rooms	2,979	
Total number yards and areas of stores and dwellings		7,211
drainage good	5,992	
bad	1,116	
fair	103	
surface condition clean	5,802	
foul	1,409	
Total number privies		5,914
under house	451	
adjoining house	165	
within 10 feet of house	367	
between 10 and 50 feet from house	3,226	
over 50 feet from house	1,705	
clean	2,246	
foul	3,607	
overflowing	61	
Total number water-closets		398
clean	273	
foul	125	
Total number urinals		153
trapped	78	
untrapped	75	
Total number earth-closets		6
Total number sinks		374
trapped	78	
untrapped	296	
Total number sewer connections		157
sound	147	
unsound	10	
Total number cess-pools		84
clean	5	
foul	79	

Total number cisterns and wells		4,744
within 10 feet of privy	369	
between 10 and 50 feet of privy	3,039	
over 50 feet from privy	1,336	
Total number hydrants		874
Total number public nuisances		1,184
Total number pools of stagnant water		124
Total number cases of infected material		569
in use	499	
stored	65	
held as merchandise	5	
Total number animals		2,616
Total number geese and other fowls		8,090
Total population		30,659
white	16,705	
colored	13,954	
Total number of families		7,384
white	3,775	
colored	3,609	
Total number dwellings occupied		5,584
by one family		
by two families		
by three or more families		(*)

B.

REPORT OF DR. CHARLES SMART.

WASHINGTON, D. C., *December* 30, 1879.

SIR: I have the honor to submit the following report of the practical results of my analysis of the water supplies of certain towns and villages in Mississippi and Tennessee:

My instructions did not require an exhaustive chemical analysis of the various waters with the quantitative determination of the saline matters which might be present in them. There was contemplated only what has been called a *sanitary analysis*, an investigation into the question of wholesomeness or unwholesomeness. But as a water which is unfit for potable uses from excess of metallic, earthy, or alkaline salts can usually be detected by its taste or hardness, a sanitary examination becomes practically an investigation into the organic matter which is contained in the sample.

The presence of organic substances can easily be detected in most waters, for there are few which are organically pure; but there is no royal road to an estimation of the quantity, nor to—what is of as much importance—an appreciation of the quality. The examination must consist in instituting a series of experiments on the organic matter, on the substances which accompany it in the water, and on those derived from it. These various witnesses are, as it were, interrogated, and from a consideration of their testimony an opinion is formed as to the quantity of the organic contamination, as to its origin in the animal or vegetable kingdom, as to its source, whether near or remote—in a word, as to the wholesomeness or unwholesomeness of the water which contains it.

The examination being of necessity complex, and each point susceptible of determination by different processes, all of which have their advocates, a consultation was held with Prof. Ira Remsen and Dr. Harmon K. Morse, of the Johns Hopkins University, concerning the ground to be covered by the examination in each instance and the best mode of accomplishing it, consistent with portability of apparatus and other considerations. I am especially indebted to these gentlemen for calling my attention to Tiemann's modification of Schulze's process for the estimation of nitrates, which they have used for some time in their water examinations, and the accuracy of which they have practically determined.

The experimental points decided upon as essential were—

First. The total solids as obtained by the balance after the evaporation of a given quantity of water;

* Statistics of morbility and mortality, as gathered by the house-to-house inspection, were so largely matters of memory and not of record that they are not thought worth presenting in this connection.

Second. The separation of this total by ignition and the balance into substances dissipated by heat, such as organic matter, nitrates, &c., and the inorganic residue;

Third. An estimation of the amount of oxygen required to oxidize the oxidizable substances present in the water, as affording a view of the organic matter from one side; while a view of the same impurity was to be obtained on another aspect by—

Fourth. The break-up of the organic substances and estimation of their nitrogen in the form of albuminoid ammonia;

Fifth. The quantity of free ammonia present;

Sixth. That of nitrous acid;

Seventh. Of nitric acid;

Eighth. Of chlorine; and,

Lastly. The miscroscopic appearances of the sediment.

With these data and a knowledge of what might be termed the natural history of the water, whether rain, well, spring, river water, &c., and of its surroundings, it was conceived that an accurate opinion could be given as to its quality, not by the operator only, but by any one conversant with the processes of water analysis, no matter what the method he adopted in the formation of his opinion.

In accordance with instructions, I proceeded to the town of Jackson, Miss., which I found mainly supplied by rain-water collected and stored in underground cisterns. As the time at my disposal did not admit of the examination of a sufficient number of these waters to enable an opinion to be given in general terms upon the character of the supply, I approximated to a generalization by selecting—

First. Water supplying public institutions, such as the State penitentiary, the deaf and dumb asylum, the institute for the blind, &c.;

Second. Public or semi-public cisterns;

Third. A few samples from the cisterns of well-to-do citizens;

Fourth. A few from those of the colored people;

Fifth. Samples from houses in which there was or had recently been malarial remittent fevers.

Thirteen samples were furnished and analyzed, with the following result:

	Cisterns.	Water good.	Water fair.	Water bad.	Sewage.
Sound	2	....	1	1	....
Siping	3	1	1	1	....
Leaky	8	4	1	3	....
Total	13	5	3	5	....

This is manifestly a bad showing—only two sound cisterns out of thirteen, one containing a water rank with vegetable impurity, while the contents of the others are not above suspicion. That the cisterns are not contaminated with sewage matter is owing to purity of soil, and not to their own merits. Several of them are neither more nor less than shallow wells, receiving more of their contents by percolation than by inflow from above.

One well-water, from northwest Jackson, was received for examination. It was organically impure, even had its use not been contra-indicated by the amount of its earthy constituents.

Having been informed by Dr. Wirt Johnston, secretary of the State board of health, that during the 1878 epidemic of yellow fever the disease passed from Jackson eastward along the line of railroad and ravaged all the settlements along the track to Meridian, except the village of Brandon, I proceeded to that place and secured samples from the sources of supply most generally used. These consisted of three wells—two springs and one cistern. The last was sound, but contained bad water. The springs were good, but one (Youst's) would have been better had the arrangements for preserving it from surface admixture been other than of the most primitive character. Of the wells one furnished good, another fair or usable, and the third an impure water.

The next place at which my instructions called for an investigation was Grenada, Miss. Here the supply was found to be from wells averaging about twenty-five feet in depth. They were all free from any excess of earthy salts.

Eighteen samples were examined, of which fourteen were good waters, one fair, and three bad. Of the last, one (Doak's) would probably have shown as a good water had a fair specimen been furnished for analysis. On investigating the well, after examination of the water, it was found that a new pump had been inserted on the day before the sample was collected and that the well was unusually turbid from this interference. The two remaining on the record as bad waters were undoubtedly contaminated with sewage.

The comparative freedom of the wells in this town from sewage infiltration is owin to the absence of privy vaults. The Mississippi State board requires the use of di earth and surface receptacles, and Grenada has been very thorough in her adoption this surface system.

For samples of the supply of small country settlements I proceeded from Grena to Duckhill, Miss., where I examined three wells, the waters of which were good, a though possessed at times of a sulphur taste on account of a blue-clay stratum whi lies below the water mark.

Returning from this place to Grenada, I collected at Elliott, Miss., samples fro three wells, two of which were good and one bad.

At Payne's place, which is finely situated from a sanitary point of view, but whi furnished twenty-five cases and thirteen deaths out of one hundred people living the during the 1878 epidemic, I obtained samples from two cisterns and one well. Tl latter furnished excellent water, but both cisterns, although sound, contained ve impure supplies.

At Green's Chapel, the only well yielded a very satisfactory water.

If the above samples from country places can be admitted as illustrations of the wel water supply of such settlements generally, their freedom from organic impurity, fro surface washings and sewage, is a matter for congratulation.

Grenada and its vicinity is thus seen to have an excellent water supply, the in purity in the few bad cases being due to local and preventable causes.

At Holly Springs, Miss., where examinations were next required to be institute twenty-five waters were analyzed, of which eighteen were from wells, five from unde ground cisterns, and two from springs.

The following tabulates the results:

	Cisterns, &c.	Water good.	Water fair.	Water bad.	Sewage
Sound	3	3			
Siping	1	1			
Leaky	1			1	
Wells	18	9	2	3	
Springs	2	1		1	
Total	25	14	2	5	

Of the wells contaminated by sewage in this town, some are owing to pollution o soil by privy vaults now disused; one arises from the neighborhood of a vault which is yet in use, another from the immediate proximity of a cow-stable, combined with a break in the curb which admits of surface inflow in wet weather. Some of the bad waters can have the organic mater contained in them accounted for only by the presence of large trees, the roots of which may lead surface-water into the well with insufficient filtration, or, being in a state of decay, may charge the inflowing water with their detritus. In several of these cases the surface around the well and adjacent tree-trunks is garden ground freely manured with farm-yard refuse.

In passing from Mississippi, where privy vaults have been abolished in favor of the surface system, to Tennessee, where they continue in general use, the character of the well-water supply was found to undergo a marked change. Sewage pollution, which up to this time had been met with only in exceptional cases, was in Brownsville, Tenn., discovered to be the general condition.

Eleven wells were examined, of which only two were good. Two furnished fair or usable water, one was bad from vegetable impurity, and six were found largely contaminated by sewage from vaults. Incidentally, it was noted by Dr. W. W. Taylor, secretary of the local board, that three cases of typhoid had occurred in a house (that of Judge Bond) supplied by one of these polluted wells.

Only two cisterns were examined, one of which was sound and contained good water, while the other was leaky—a veritable shallow well—and contained a most impure supply.

In a thriving town like Brownsville, where the soil has become so contaminated as to infect the wells in this manner, it is high time for the establishment of a sewerage system. The vaults should be abolished in the mean time, and the Mississippi surface system instituted. But this is beyond the limits of my inquiry, and is mentioned only in passing.

So far as the water supply is concerned, it is imperative that some action be taken by the local board. The town is ripe for decimation by typhoid fever and other diseases which originate in impurity of soil and are propagated by impure water. The proper remedy is the organization of a water company and the introduction of a sup-

ply from a suitable source entirely beyond the risk of pollution by the consumers. But if this requires an expenditure exceeding the means of the town, recourse must be had in the mean time to a rain-water supply, or, in certain localities outside of the denser areas, to deep wells lined with brick to exclude infiltration from the surface.

The city of Memphis, Tenn., was found to depend for its supply upon three unequal sources, which, in the order of their importance, were—

First. The underground cisterns, of which it was estimated that there were no less than four thousand in use within the city limits.

Second. The wells, of which there were quite a number, but many of them were not used on account of a bad repute, based principally on the hardness of the water or the taste of its inorganic salts.

Third. The hydrant water, or that furnished from the Wolf River by the Memphis Water Company.

Eighty samples of cistern water, from various parts of the city, were examined, with the following result:

	Cisterns.	Water good.	Water fair.	Water bad.	Sewage.
Sound	36	25	8	3	....
Siping	12	2	1	2	7
Leaky	32	6	2	....	23
Total	80	33	11	5	31

But these cannot be viewed as illustrating the condition of the four thousand cisterns in the city, inasmuch as, although they came from all quarters, they were in every instance selected samples. Many were brought for examination by citizens whose very anxiety concerning their water supply might be looked upon as an argument in favor of the probability of the cistern being sound and the water pure. Other samples, as those from the public schools, were sent in mainly for the purpose of verifying their purity. On the other hand, samples brought by the medical inspectors for analysis were presented on account of their probable impurity, while the last nine of the waters which were examined were selected by the analyst from a list of those known by preliminary examination to be impure.

But while one may not generalize concerning the Memphis cisterns from this table, it shows conclusively that the impurity of the soil is such that when a leak exists in the cistern the probabilities are strongly in favor of a pollution by sewage of the contained water.

As the complete sanitary analysis of a water occupied so much time, and as the number of cisterns was relatively so immense, a ready method was sought by which the condition of a cistern and the probable quality of its contents might be determined.

At first sight the amount of total solids in a stored rain-water would seem to afford the means of judging as to the soundness of its cistern, any sipage or leakage of necessity carrying into the water earthy and other salts which would increase the total. But several instances occurred in the above analyses where lime carbonate in the residue came manifestly from the cement lining of a sound cistern. This method had therefore to be excluded as fallacious.

No objection, however, attached to an estimation of the chlorine present in the water as an index of the condition of the cistern. Rain-water contains a small proportion of chlorine, the amount varying with the condition of the atmosphere and the purity of the shedding surface. In the inland city of Memphis the amount naturally existing in its rainfall is not large. Rain which was shed from the roof of the Peabody Hotel, during a heavy fall on December 3, contained .075 parts of chlorine in the 100. A cistern water which does not contain more than this must be undeniably free from soil pollution, for the finished analysis showed the soil to be so charged with chlorides that the slightest siping or leakage was marked by an increased chlorine figure. A small excess over the normal might exist and the cistern be sound, the increase being due to an unusual foulness of the roof. As much as .15 parts of chlorine was shown to be consistent with soundness, but as the amount increased beyond this figure the probability of leakage became proportionally great. A series of chlorine determinations was then made on cistern samples collected from all the wards of the city; and, as no selection was exercised, the results may be viewed as expressing the condition of the Memphis cistern supply.

In tabulating them, those waters which contained less than .075 parts of chlorine are set down as from *undoubtedly sound* cisterns, the supply itself being in all probability of good quality. In cases where the amount lay between .075 and .15 parts the cisterns are recorded as *probably sound*, the increase being due to vegetable contamination and

foulness of the shedding surfaces, although in a small proportion of the cases it might be owing to a slight siping from the soil. Here the water must be considered of doubtful quality. In those instances where the chlorine figure lay between .15 and .30 parts, the cistern is reported as probably *siping*, the increase coming from the soil, and being in all likelihood a sewage accompaniment, although in rare cases it might arise from a large organic impurity without leakage on the part of the cistern. In either case the water is probably bad. Lastly, where the amount exceeded .30 parts in the 100 of water, the cistern is viewed as undoubtedly *leaky*, and as containing an impure water supply.

CISTERNS EXAMINED.

Undoubtedly sound	127
Probably sound	82
Probably siping	82
Undoubtedly leaky	158
Total	449

In estimating the condition of the Memphis water supply from this source, there should be added to the above figures nine leaky cisterns, making 167 in a total of 458. These nine samples were brought in for the chlorine experiment along with the others, but a complete sanitary analysis having been subsequently made to determine the characters of their impurity, they were removed from the list of cisterns examined to that of cistern-waters analyzed.

The large proportion of leaky cisterns, with the strong probability of sewage contamination in each instance, requires that some action be taken to insure a better water supply for the city. But whatever may ultimately be done in this direction, the citizens will have to depend upon their cisterns for some time to come. Yet the character of many of these waters is such as to call, in the interest of the public health, for an immediate interference. In several instances I was enabled, by personal communication with the owners, to warn and advise. But in other cases, where the water was brought by the inspecting officers, I did not have the means of notifying the consumers. To overcome this difficulty and enable action to be taken in the cases of certain cisterns, which from their excessive leakage appeared to require immediate attention, I sent a communication embracing some of the facts here recorded to Dr. R. W. Mitchell, member of the National Board of Health, and of the committee on the sanitary survey of Memphis, with a list of sixty-five of the worst cisterns and a map giving the location and character of the whole number examined.

But the facts developed by the analyses constitute only a small part of the total array which demands investigation in the sanitary interests of the city. Among the thirty-five hundred unexamined cisterns there are at least twelve hundred which leak. These should be singled out by the local authorities by means of the chlorine test, and their abandonment should be ordered if there is manifest danger from soil pollution in their surroundings; but if there is no such danger it would be sufficient to direct them to be cleaned out and relined with a thick coating of Portland cement.

The analyses of the well-waters demonstrated the impurity of the city's soil in as marked a manner as did those of the leaking cisterns. Of nineteen wells, all of which were reported as brick-lined to exclude infiltration, fourteen contained sewage matter, either in the recent state or oxidized by its passage through the soil. Of the five remaining, the use of one was contra-indicated by an excess of earthy salts, so that there were in reality only four waters, out of this list of nineteen, which could be warranted as fit for use. Of those which showed the presence of organic matter in an oxidized condition, one—Pontotoc—was so free from recent contamination, and at the same time contained such a small proportion of oxidized matter, that the *water* might be considered as wholesome. The *well*, however, must be looked upon as dangerous, inasmuch as an increased flow of water into it might at any time bring unaltered sewage to pollute the supply.

The waters might be thus classified:

Four good in every respect.

One doubtful, as liable at any time to contamination.

Eight bad in every respect.

Four potable so far as recent organic matter is concerned, but condemned on account of oxidized organic matters and excess of inorganic salts.

One unwholesome solely on account of dissolved inorganic salts.

One potable so far as inorganic constituents are concerned, but condemned on account of organic pollution.

In connection with the cistern and well-water supply of Memphis I have especially to thank Dr. R. W. Mitchell, member of the National Board of Health, and Dr. Frank W. Reilly, superintendent of the house-to-house inspection, for the assistance they furnished in securing the necessary samples for analysis, and for many valuable suggestions connected with my work.

Besides the cisterns and wells above enumerated, the examinations at Memphis included one water from a tank or reservoir built above ground, one rain-water collected direct from a roof, in order to place on the record the sanitary analysis of the rainfall which was then filling the cisterns, and thirteen samples of river water, one from Elmwood Creek, three from the Mississippi, and nine from the Wolf River.

The supply furnished by the Memphis Water Company is drawn from Wolf River, a short distance above its mouth. It is pumped from the river and distributed without any intermediate process of purification.

During the period of my stay in Memphis, Wolf River was an uninviting stream, turbid with particles of red clay, which, on account of their extreme minuteness, rendered filtration difficult—from the tendency of the particles to clog the filter—and sedimentation practically impossible. Entangled with the clay there was much vegetable matter, which could be separated only by the separation of the mineral particles. Hence analyses of the water made on samples taken on November 12 and 18 and December 2 and 15 showed it to be unwholesome in a high degree. Many householders who were doubtful as to the condition of their cisterns made use of this water after passing it through a charcoal filter. One such filtered sample was examined and found to be a specimen of very pure water. Those citizens only who made use of the filtered water had an interest in this result, which is to be set to the credit of the charcoal, not to that of the water. Sedimentation was accomplished on the small scale in a few instances by filling cisterns with the river water at a time when the stream was low and comparatively clear. Three samples of water stored in this manner were examined and found to be of good quality. But the long-continued sedimentation in a clean cistern which is to be credited with this result is a process which, like the charcoal filtration, can be accomplished only in individual cases.

It is no doubt true that at other seasons of the year this stream is less impure than at present, but a water, to be suitable for the supply of a large city, should be pure at all seasons, or, if not, it should at least be susceptible of purification on the large scale. The Wolf River water, unfortunately, cannot be thus purified. Any filter which might be constructed would be clogged within a few hours, and a series of reservoirs, to permit of subsidence, would require to be of extravagant size unless some means were devised to hasten the process.

With the view of ascertaining the character of the water higher up the stream than the location of the water-works, a sample was procured on November 18 from Raleigh, a point nine miles distant from the city. This specimen was found to be somewhat less impure than that collected on the same day near the water company's inflow. But it was unwholesome from an excess of vegetable matter, and as objectionable as the other when viewed as a possible source of supply. It was loaded with the same red clay which renders the hydrant-water so difficult of purification.

In order to effect a comparison between the waters of the Mississippi and Wolf Rivers, Capt. W. H. H. Benyaurd, Corps of Engineers, United States Army, who furnished the samples already mentioned, collected specimens of the Mississippi on November 18 and December 2 and 15. But these were insufficient for the purpose. The periods of flood in the two streams are not coincident. On the first of the above dates Wolf River was somewhat swollen, while the rise in the Mississippi had not commenced. The Mississippi water was then a fair sample of river water, containing a certain amount of vegetable impurity, but by no means so much as has been recorded as existing in some Western streams of good repute as to wholesomeness. On the second date, the Mississippi sample, although very turbid—the river being 7½ feet above low-water mark, and rising—was comparatively free from organic matter. On the third occasion, the river had risen to 10 feet, and was exceedingly turbid. When the Mississippi is at this height, its waters impede the outflow from Wolf River, causing stagnation and flooding in the mouth of the latter. The sample presented the same amount of organic impurity as that furnished by the Wolf River water collected on the same day, enough to condemn it as unfit for potable use.

To establish a comparison between the streams, the annual lines of organic impurity should be determined. But continued observations of this nature do not appear to be called for to decide the question as to which is the better water for a town supply. Both are pure when at low-water mark, and free from impurity. Both are impure when swollen and turbid. So far they agree. But the red clay of the smaller stream rises into turbidity more readily and falls more slowly than the more siliceous sedimentary matters of the Mississippi. This would suggest that the annual period of turbidity and consequent impurity is less in the Mississippi. But the possibility of purifying a supply drawn from it should cause it to be preferred, even if its period of turbidity were greater than that of Wolf River. So far as dissolved inorganic substances are concerned, both waters are of good quality.

This report has, of course, no consideration for the engineering and financial sides of the question.

I have the honor to accompany this report with an itemized list of the various well, spring, river, and cistern waters analyzed, and of the Memphis cisterns tested chem-

ically for leakage. I also append a copy of the letter referred to above as having been sent to Dr. R. W. Mitchell with the view of reaching the local authorities of Memphis.

I have the honor to be, very respectfully, your obedient servant,

CHARLES SMART,
Captain and Assistant Surgeon, U. S. A.

THOMAS J. TURNER, M. D., U. S. N.,
Secretary National Board of Health, Washington, D. C.

MEMPHIS, TENN., *December* 19, 1879.

SIR: I have the honor to report to you that I have concluded my investigation as to the character of the water supply of Memphis; that I have analyzed a sufficient number of the waters collected and stored in the different wards of the city of Memphis to be able to generalize on summing up my results.

Whatever system of water supply may be adopted by the city in the future, the point of immediate interest is the condition of the cisterns. These will have to be used in the mean time, while awaiting further devlopments. During my examinations I have met with many waters so polluted by sewage infiltration that an immediate interdict on their use appears called for. In many instances I have been enabled to do this by personal communication with the owners; but in other cases, where the water has been brought to me by the inspecting force, I have not had means of notifying the consumers.

In view of the importance of this subject, and of the large amount of facts gathered by analysis during the past few weeks, I have conceived it proper, without trenching on the ground to be covered in my report to the secretary of the National Board of Health, and without awaiting the routine transmission of official communications, to furnish you with some memoranda from my laboratory record, that, subject to your approval, they may be laid before the local authorities and utilized. To the better understanding of the subject a few words are necessary.

On commencing my investigation in this city I made an exhaustive analysis of every water which was presented, determining the total amount of solid matter dissolved in the water, the organic matter, and all those substances which accompany, or are formed by, the breaking up of the organic matter. When a large number of these were collected it became manifest, on reviewing them, that the amount of chlorine present in a cistern water could be made the test of soundness or leakage of the cistern. On superficial consideration it would seem as if the total amount of dissolved solids would be the best criterion, as rain-water, properly stored, contains such a small proportion of these matters; but many instances occurred showing the presence of lime in comparatively large quantities without that corresponding increase in the chlorine which would be expected if the lime salts siped in from the soil. The inference was that the lining of the cistern was undergoing solution by the water—an important fact as bearing on the permanence of a cistern in its sound condition, but rendering the total solids, as determined by the balance, of no value as a test of leakage. On the other hand, rain-water contains but the merest trace of chlorine, collected, in its fall, from the sodium chloride which exists in the dust of the atmosphere. It gathers a little more from the roof which sheds it; so that rain-water taken from a cistern gives perceptibly more chlorine to the chemist than that collected in clean dishes. From a sound cistern the water can gather none, so that its presence in excess of the amount normal to roof-caught water is indicative of siping or leakage from the soil. In this city no water which has percolated the soil can be found without chlorine, and hence no leak can exist in a cistern without its presence being detected by a determination of the chlorine present in the contained waters. Having arrived at these conclusions, an examination was made of a large number of cisterns by means of the chlorine determination. Many were found so strongly charged by this contribution from the soil that a larger quantity of water was obtained from the cisterns in question, for fuller investigation, to determine the quality of the matter, indicating such an amount of chlorine leakage. The full analysis which I have placed on record gives a value to the simple chlorine determinations, by indicating the probable quality of the water, which corresponds with a given chlorine impurity. But this is a matter for my detailed report.

Accompanying this communication is a map of the city, on which are indicated the sites of 80 cisterns, the water of which has been examined exhaustively, and of 450 cisterns the condition of which has been determined by an estimation of the chlorine. On the map a black circle marks the position of a sound cistern with a presumably good water; a blue circle marks a probably sound cistern; a green circle a cistern which probably sipes a little, or which, in a small proportion of the cases, obtains its excess of chlorine from the accumulations of vegetable matter washed down from the roof; a red circle marks the situation of a leaky cistern, which, if the privy vault adjoins, contains contamination from that source. The circles which are filled in with solid color—black, green, red—indicate sound, siping, and leaky cisterns re-

spectively, and the waters of which have been exhaustively examined. The letters G, F, B, and S express the quality of the examined waters, as good, fair, bad, sewage, as the case may be.

Many of the 530 cisterns leak, but some, of course, to a much smaller extent than others. I accompany this with a list of the more exaggerated cases in which it appears to me that immediate action is demanded. The others, not in this list but marked as "leaky" on the map, require attention, but not so imperatively. These should be filled up, if there is manifest danger of soil pollution from these surroundings; but if there appears no such danger, it would be sufficient to clean them out and reline with Portland cement.

Another point which deserves attention is this: The proportion of leaky cisterns is large—in round numbers one third of the whole—while again of these the number largely contaminated may be judged of by the list. The number examined (530) is sufficient to indicate the probabilities in the 4,000 (?) or more cisterns which Memphis owns. If it appears imperative, in the sanitary interests of the community, to take action in the cases which have been examined and pronounced polluted, it is no less imperative to find out and remedy the many cases which have not been examined, but which of necessity exist. To this end I would respectfully suggest a continuance of these chlorine determinations by some competent person, in order that the leak may be stopped in those cisterns which it is proper to reline, and that the dangerous ones be destroyed. These experiments are simple, do not occupy much time, require no expensive apparatus, and are accurate in their testimony as to the condition of the cisterns.

I have the honor to be, very respectfully, your obedient servant,

CHARLES SMART,
Captain and Assistant Surgeon, U. S. A.

Dr. R. W. MITCHELL,
Member of the National Board of Health,
and of the Committee on Sanitary Survey of Memphis.

APPENDIX M.

REPORT ON THE WATER-SUPPLY OF NEW ORLEANS AND MOBILE.

BY CHARLES SMART, M. D., *Assistant Surgeon, U. S. A.*

Under date of April 4, 1880, Dr. Smart submits the following report of an investigation into the character of the water-supply of the cities of New Orleans, La., and Mobile, Ala., undertaken in accordance with instructions from the executive committee of the National Board of Health, dated February 7, 1880:

The city of New Orleans is supplied by rain-water collected and stored in cisterns, by Mississippi water furnished from the water-works, and by a few shallow wells. The principal source is that first mentioned. It is preferred by the citizens as purer and less turbid than the Mississippi water, and as free from those surface and soil impurities which are liable to pollute the wells. It is believed that the city owes its immunity from typhoid fever to the freedom of the cistern supply from sewage infiltration.

The cisterns are constructed of cypress wood, and vary in size from 500 to 60,000 (Morgan Depôt) gallons. The usual capacity of the dwelling-house cistern is about 2,000 gallons. They are raised a few feet from the ground, and their contents are protected by a lid or cover. Some are placed under the shade of a balcony; a few have a special roof over them; but the majority have only such protection from the rays of the sun as is afforded by their position against the house-walls. Many, especially in the older parts of the city, are situated in unventilated inclosures which are rank with the emanations from unclean privies.

The rain-water shed from the house-roof carries with it into the cistern the soot and condensed ammoniacal vapors of coal combustion, the infinity of *débris*, organic and inorganic, which constitutes the dust of a large city, together with more massive fragments, as of dead insects and decaying leaves, &c. After a few days these various matters settle, forming a soft, black, pultaceous sediment, and leaving the supernatant water comparatively clear and pure. But every succeeding rainfall not only increases the quantity of this sediment, but, by its inflow, stirs up that which had already accumulated, rendering the water impure until sedimentation is again accomplished. As time passes the sediment increases, and the water becomes unfit for use after each

rainfall. These conditions are aggravated in the dry season when the water is low in the cistern and the quantity of sediment is relatively much increased.

As a number of the cisterns which were examined had not been cleaned out in many years, some observations were made on the rate of increase of the sedimentary layer to determine the proper interval between successive cleanings. Dr. DeLoffre, U. S. A., undertook these observations, and by careful soundings, in fifteen cisterns, determined the rate of deposit in the average cistern at one inch per year. The rate as thus given corresponds with the experience of individuals engaged in the cistern-cleaning business.

To ascertain the character of the city dust which is washed into the cisterns, a quantity was obtained from some open upper rooms in a public building which had not been cleaned in several years. This gave 17.2 per cent. of moisture, 34 of matter destroyed by heat, and 48.8 of mineral residue. Of the dry dust 11 per cent. was dissolved by maceration in water for twenty-four hours. Six of these 11 parts were inorganic salts, and 5 were organic matter, which manifested its quality by requiring, per 100 parts, 668 parts of oxygen for its destruction, and yielding, per 100 parts, 6 parts of albuminoid ammonia. The residue insoluble in water contained nitrogen enough to furnish .5 per cent. of organic ammonia, indicating the presence in it of organic matters, which prolonged maceration and fermentative changes might reduce to a soluble condition.

Having thus determined the solubility and nitrogenous quality of the city dust in its relation to water contamination, a sediment was obtained which had been accumulating and macerating at the bottom of the cistern for eight years. This consisted of 73.4 per cent. of mineral matter and 26.6 of matter destroyed by heat. One hundred parts yielded .54 parts of albuminoid ammonia, showing the presence of insoluble organized material which fermentative action and vegetable growth and decay occurring during the warm months might bring into a state of solubility.

In view of the chemical character of the dust which is carried into the cisterns, and especially of that of the sediment, of which the dust constitutes but one element, it would appear advisable to have such cisterns as are in use in New Orleans cleaned out annually some time before the occurrence of warm weather. But this is needful only in the event that no other means are adopted to preserve the water from impurity and the cistern from sediment.

The first rain which enters a cistern after a season of dry weather is so unmistakably impure from roof-washings that its rejection is immediately suggested as a means of preserving the purity of the cistern. Yet there are very few instances in which this idea is carried out. The majority of the people permit everything from the roof to collect in the cistern, which is cleaned only when the impurity of the contained water forces itself on the senses. Nevertheless some samples were obtained from cisterns which were guarded from a turbid inflow by means of what is known as the *cut-off*. The simplest form of mechanism to effect the rejection of the roof-washings consists of a joint in the conductor, which, when in place, leads the water into the cistern, but which, when turned, runs it to waste. Several forms of cut-off were shown to me while in New Orleans. One of the best (Cassidy's) consists of an overflow-pipe running down along the outside of the cistern and guarded at its free end by a valve which can be opened or shut at pleasure. The conductor from the roof opens into this pipe a few inches below its upper end or point of emergence from the cistern. When the valve is open, water from the roof runs to waste through the pipe; when it is closed the water is carried over into the cistern, while accidental solids are trapped in the pipe. Automatic cut-offs have been suggested. In one (Le Blanc's), a certain proportion of the water which is rejected is drained into a vessel, which, by its weight when filled, removes the cut-off and permits of ingress to the cistern. In another (Dr. Sternberg's), a wooden float on the waste-water receptacle restores the continuity of the conductor. A cistern which had been guarded by a cut-off for five years was emptied for the purpose of being cleaned. Instead of five inches of carbonaceous pulp, the sediment formed only a filmy coating on the bottom and sides of the cistern.

There are other means in use in exceptional cases for excluding sediment from the water-supply, the more common being a conjunction of two cisterns, the second receiving its contents by an overflow-pipe from the first. In one instance the first or sedimenting cistern contained an iron tank, into which the water from the roof was received and from which the cistern was filled by overflow. The second cistern communicated by an overflow with the first, and, as a further means of insuring purity, the water before reaching the delivery faucet had to pass through a sandstone diaphragm.

The processes adopted for the determination of the wholesomeness of these cistern waters were those which were used in the analysis of the Memphis supply. The total quantity of solids in the water and the amount of these lost on ignition were taken by the balance. The nitrites, nitrates, chlorine, and ammonia were determined, as also the quantity of oxygen required to oxidize, and the quantity of albuminoid ammonia evolved in the destruction of organic matters. The sediment was examined microscopically. The volumetric estimation of chlorine, so useful as an indication of con-

taminated water in the underground Memphis cisterns, was of no value in the present instances, as none of the waters contained more than was normal to roof-caught rain. Nitrites were not present in any of the samples, and nitrates existed only in the minute traces proper to rain-water. Ammonia varied in quantity with the rainfall and the freedom from combustion products of the roof which shed it, and was therefore of no value as an indication of organic impurity. The oxygen process, although of use as an index of purity, failed to give satisfactory evidence with regard to impurity, inasmuch as free carbonaceous particles were estimated by it as if they were the carbon of complex organic substances. Wanklyn's albuminoid ammonia process afforded the best insight into the character of the waters, and the results were in accordance with the microscopic evidence, increasing amounts of organic ammonia corresponding with increase in the number of low forms of life until the amœbæ, cercomonas, and vorticels of swamp-water became the prevailing forms.

The quality of the water in the New Orleans cisterns fluctuates with the rainfall. A clean cistern containing an excellent water may have its contents deteriorated by the inflow of a casual shower laden with all the dust and air impurities of a dry season; and this even when a cut-off is used to reject roof-washings. The air impurity continues to fall for a long time after the roof is thoroughly washed. On March 8, following several weeks of dry weather, 3.3 inches of rain fell on the city. A sample collected during the first half hour of fall gave .030 parts of albuminoid ammonia per 100,000. Another specimen, collected toward the end of the fall, yielded .021 parts. It is clear that this shower, even if its first portion had been run to waste in roof-washing, would have filled the cisterns with a very impure water, loaded, as shown by the microscope, with recent vegetable tissues, starch cells, confervoid filaments, zoöspores, cotton fibers, fungi, and mineral fragments. On March 12 another rainfall was examined, a sample collected during the first three hours yielding .030 parts of organic ammonia per 100.000, while the amount furnished by the remainder of the shower was but .012 parts. Wet weather set in after this date, yielding the cisterns a yet purer water. My examinations were concluded before the occurrence of the rainy weather, and the results of necessity show a higher degree of impurity in the cistern waters than would have been obtained at a later date.

Forty waters were examined. A large proportion of these were from well-conditioned cisterns attached to public buildings, schools, and private dwellings. Not more than half a dozen samples were presented by the inspectors as illustrative specimens of bad cistern water. Among the former were specimens from the house occupied last year by General J. B. Hood, and from other dwellings in the same yellow-fever infected neighborhood, but these proved to be, on the whole, above the average as to purity.

Of the forty waters, ten yielded .010, or less, parts of albuminoid ammonia per 100.000; twenty-two gave from .010 to .020 parts; while in eight the yield was over .020 parts. The second or largest class may be taken to represent the average of the city waters; the first includes several where special means are taken to exclude sediment; the last represents the old, foul, and uncared-for cisterns. The worst sample presented, chemically and microscopically, the characters of swamp-water. It was furnished as coming from a new cistern to which suspicion of lead-poisoning attached. No lead was present, but the specimen yielded .070 of organic ammonia. Remittent fever developed in the house while the water was under investigation, and the cistern, being suspected, was disused. The house was situated in a well-paved district (Bourbon and Bienville), but the cistern, instead of being new, was very old and rotten. These facts were elicited by inquiry after examination of the water. Water from the swamps beyond the city yielded .090 parts of albuminoid ammonia.

The first of the above classes may be called pure waters, as the purest rain-water collected in country districts at the end of a long-continued fall seldom yields much less than .010 parts of ammonia from its organic matter. Those giving from .010 to .020 parts may be called usable or allowable waters, as experience shows their use to be unattended with evil consequences; but when the organic matter yields more than .020 parts the water must be assumed to be dangerous, on account of its approximation in quality to that of the swamps and of the occurrence of numerous instances where malarial developments can be directly attributed to its use.

A familiar method of rating the impurity of a given water may be obtained from the results of Wanklyn's process by erasing the decimal point and the cipher or ciphers which follow it. Organically pure water, .000 parts per 100.000, becomes the zero of the scale. Spring water, .000 to .004 parts, has an impurity figure of 4 or less; pure rain water, 10 or less; usable cistern waters, 10 to 20; dangerous waters, over 20. By making use of this relative scale I was enabled to speak of the impurity in various waters so as to be understood with precision by those who, while interested in the waters in question, were ignorant of the methods of analysis and of the value to be attached to determinations of albuminoid ammonia.

But while the average cistern showed an impurity figure of 10–20, and while these figures became somewhat reduced by subsequent long-continued rains, it must be

remembered that the waters at this time were probably at their minimum of impurity. During the summer and autumn, when fevers are prevalent, it is certain that the cistern water is more highly charged with organic matter than is the case at present. Under the influence of heat and light chemical changes take place in the sediment with growth and decay of microscopic life, tainting the water in most of the cisterns so that the senses can take cognizance of its impurity. In the sound cisterns of the city of Memphis, cool from their underground position, much purer waters were obtained than the best samples from the city of New Orleans. The underground position appears to induce changes favorable to the purification of the water. Wolf River water stored in these cisterns underwent the same process of purification. Rain water can be drawn from them as pure as that from natural springs. But deterioration rather than improvement is the rule in the exposed wooden cisterns of New Orleans. Cleanliness of cistern effected by the use of a cut-off, with efficient shade and ventilation, will tend to retard the deterioration; but it is doubtful if water should be used from such cisterns for drinking purposes without undergoing some process of purification. The contents of the best of them are susceptible of improvement. Many intelligent persons recognize this fact, and make use of various forms of filter to effect the purpose. Some of these act in a purely mechanical manner by separating solid matter. The result is a water which presents its cleanliness to the eye as proof of a purity which it may not possess. Water from the drainage canals sedimented for a few days is clearer than many of the cistern waters, and yet it is neither more nor less than the sewage of the city. The sandstone diaphragm in a cistern already mentioned is an example of valueless filtration. The organic matter in the water was unaltered by its transmission through the pores of the stone. On the other hand, a sandstone filter in another cistern which was examined gave a clear water, pure in every respect. The stone in this instance was hollow and about the size of a five-gallon keg. Air was freely admitted into its interior by a ventilating tube which rose from it to a point above the high-water mark of the containing cistern. The pressure of the superincumbent water caused an influx through the pores of the stone, which appeared as a dew on the internal surface where it came in contact with the contained air. The water was thus presented for aeration under favorable conditions, somewhat analogous to those attending the aeration of the blood in the lungs. It collected in the interior of the stone keg, from which it was drawn off by a pipe and faucet. In the diaphragm there was a simple straining of a continuous current of water. In the keg there was in addition to the straining a very efficient oxidation of dissolved organic matter.

But these efforts at purification occur only in exceptional instances, where an appreciation of the water impurity coincides with the financial ability to undertake its removal. What the city requires is a simple method of filtration which can be accomplished at an almost nominal expense. I have suggested and sent to New Orleans a model of a filter which may fulfill the requirements of the cistern waters. If it is found that the tin-workers can furnish it at a price which will put it within the reach of everybody, I shall have one made here for the purpose of testing its action and determining the period when the charcoal packing will have to be renewed. It cannot be excluded from use as infringing on any of the many patents, as the principle of funnel filtration or percolation is common property, and the suggested method is funnel filtration through charcoal and sand reduced to its simplest form. The filter in the model is made of tin, and consists of a modified funnel, the body of which rests on a tin bucket or receiver, while the tube projects downward to the bottom of the said bucket. The lower end of the tube is tied over with some filtering cloth. Three-fourths of its length is filled with granulated bone charcoal and the upper fourth with sand. The upper end of the tube projects about half an inch into the body of the funnel to permit of tying a filtering cloth over the top of the sand. The angle between this projection and the sloping sides of the funnel will serve to trap solid matters. To clean this filter, the filtering cloth guarding the top of the tube will have to be removed, washed, and replaced. At longer intervals, when the filter shows signs of clogging, half an inch of the upper layer of sand may be removed and replaced by fresh material. At yet longer periods, depending on the length of time during which the charcoal retains its powers of oxidation, the whole contents of the tube may be dumped out and renewed. Earthenware is more durable than tin, and would preserve the water cooler during the warm months. Some such method as this is desirable for general adoption in connection with the cistern water supply, and, as many of the citizens have expressed an interest in the matter, it is hoped that something may be accomplished.

I had the honor on two occasions, while in New Oroleans, to discuss the question of water supply before the auxiliary sanitary association. The attention of the association was specially invited to the character of rain-water, to impurity in cisterns, to the connection between disease and impure water supplies, and to methods of purification. A resolution of thanks was passed by the association, and provision made for the publication of the papers in pamphlet form for general circulation.

I have to thank Dr. Herrick, secretary of the Louisiana State board of health, and Mr. Horter, vice-president of the citizens' auxiliary sanitary association, for furnishing me with the necessary samples for analysis.

In connection with the drinking-water supply, two samples of ice were examined, one marked Boston the other Louisiana ice. Both specimens yielded satisfactory results.

During the period of my stay in New Orleans the Mississippi River was flooded to the danger line and was exceedingly turbid. Its water was totally unfit for drinking, except when efficiently purified by household filtration. The turbidity was similar in character to that of Wolf River, which was investigated last autumn. It consisted largely of microscopic points of clay. The sand and grosser particles subsided within 24 hours, but many days of sedimentation were required before the fine clay cloud would leave the water of ordinary clearness. Much difficulty would be found in treating this water on the large scale, so as to procure a satisfactory supply at all seasons. Even household filtration is troublesome on account of the impermeability of the first deposited layer of clay. The filters require frequent attention. The water is used, however, in several instances after filtration. Samples passed through sandstone gave results satisfactory in proportion to the perfection of the aeration. Charcoal filtration yielded excellent results. Filtration through paper was impossible. Sedimentation for 24 hours did but little to free the water from dissolved organic matter or from that held in suspension along with the fine clay. The river water is, no doubt, as at Memphis, purer during the summer and autumn, when the stream is low and comparatively free from suspended matters. More hydrant water is used in the household economy at these times, which fortunately correspond with the period of scarcity and of maximum impurity in the cisterns. The filter suggested above, in connection with the cistern supply, is unsuitable for the turbid river water.

The well waters of New Orleans are unfit for use. They are but little less impure than the sewage water carried off by the drainage canals, yet they are reported as being employed for family use, in bakeries, and for stock, especially in the summer, when the cistern supply fails. The site of the city is water-logged to within a few feet of the surface. One well on Chestnut street, the least impure of those examined, is only 10 feet deep, and contains 7 feet of water. The saturated soil is of great depth, and the ground-water is practically stagnant. The filtration into the wells is insufficient even to free the water from turbidity. Organic matter is unaffected by the process. The water contains alkaline carbonates, chlorides, large amounts of free ammonia, but no nitrates or even nitrites. In four wells examined, the ammonia from organic matter amounted to .030, .041, .044, and .080 parts; while in the sewage from the Orleans canal it only reached .120 parts. These samples are so impure that the use of well water in New Orleans should be interdicted. Even careful filtration should not be relied on to purify such waters. Filtration is not a process by which dangerous waters may be utilized, but simply a guard against the possibility of danger in doubtful waters.

The city of Mobile, Ala., has an excellent water supply, said to originate in springs about 6 miles from the city. The water, however, appears to consist of the rainfall filtered naturally through sand, which, while diminishing the quantity of ammonia and organic matter, gives but little increase to the mineral constituents. But as this supply is at present rather costly, bored and dug wells are in common use in many parts of the city, and furnish the exclusive supply in the outlying districts.

Four samples of each of these well waters were furnished by Dr. Scales, health officer of the city, for analysis.

The dug wells have a depth of about 18 to 20 feet. The mineral constituents of their water are alkaline carbonates, chlorides, and nitrates, varying from 70 to 120 parts per 100,000. These show the water to be of foul surface derivation, but altered for the better by its percolation through the soil. Nevertheless, three of them (north side Broad, corner Lawrence and Bloodgood, and corner Lawrence and Erlura streets) contain so much unaltered organic matter as to merit unqualified condemnation. The fourth (west side Conception, between Augusta and Savannah streets) gives a better water. Its supply is manifestly derived from deeper strata than that of the others, although its reported depth is only 25 feet. Its water is similar to that in the bored wells, but there are, in addition, signs of recent surface infiltration which cast suspicion on the well, although the water contained in it at the present time may not be unwholesome.

The bored wells yield a water which contains but little inorganic residue and is comparatively free from organic matter. One of them, however (on Conception, between Adams and Congress), leaks directly from the surface and is contaminated. The others (corner State and Franklin, Saint Michael, between Warren and Dearborn, and corner Davis avenue and Lawrence) contain waters in which the organic matter is represented at the present time by the presence of harmless nitrates. In such cases I have been in the habit of reporting to the individuals interested that the water is good but the well of doubtful character. Some accident may at any time interfere

with the efficiency of the natural filtration; some leak may admit surface water from the overlying strata to taint the purity of the well supply. These wells are from 50 to 65 feet deep, and contain only one-tenth of the solid matters which are found in the shallower wells. Their water must, therefore, come from a distance, instead of by percolation from the overlying surface. This fact appears to guarantee the purity of their waters for many years to come. Indeed, the probabilities are that, if leakage from above is excluded, the wells may be trusted indefinitely to furnish a pure supply.

Only one specimen of cistern water was sent for analysis from Mobile. It was forwarded by Dr. Gaines as a sample of the water supply used in a house where remittent fever prevailed in the absence of prominent sources of malarial exhalation to account for the presence of the disease. It was largely charged with vegetable organic matter, giving .035 parts of albuminoid ammonia and requiring 1.199 parts of oxygen per 100,000.

While the waters from bored wells are satisfactory, although liable to pollution in individual instances, it is to be hoped that the city may soon be enabled to do away with the necessity for their existence and for that of the shallow wells and impure cisterns which furnish a large part of the present supply. Enlargement and extension of the water-works would remedy the evil.

WATER ANALYSIS.

BY DR. CHARLES SMART, *Assistant Surgeon, U. S. A.*

SECTION I.

GENERAL PRINCIPLES OF SANITARY ANALYSIS.

The methods adopted in the analysis of potable waters have undergone a radical change during the past generation. A knowledge of the composition, relations, and affinities of inorganic substances preceded investigation into the complexities of organic materials. Most waters contain both of these classes of matter, but the chemist in analysis slurred over the unknown and apparently insignificant and devoted all his attention to the known and prominent constitutents. Chemistry had reduced inorganic salts to their elements, and had discovered the laws of quantitative combination. The analysis of a complex admixture of inorganic substances such as exists in natural waters became, under these circumstances, a resolution of the existing compounds into other and known combinations of their elements by which their kind and quantity were determined. The report of the investigation was therefore a quantitative statement of the carbonates, sulphates, chlorides, &c., existing in a given quantity of the water. This is the popular idea of water analysis at the present time; and, in many instances, where the attention of the individual has not been directed to questions of water impurity, it is the professional idea as well.

Nor is this surprising; for general chemistry has been slow to give up its exhaustive and formal analyses and to accept instead the fragmentary analytical work which has been developed by its sanitary section. The text-books in common use teach methods for the detection, separation, and estimation of the iron, alumina, lime, magnesia, &c., which may be present in a potable water, while the obscure organic matter is, or was until recently, passed over almost in silence. The loss of weight which a water residue suffers on ignition was the nearest approach made to an estimation of the organic substances, and here the result is obscured by the disappearance of other volatile matters which may have been present in the residue.

The formal analysis of general chemistry is in place where a mineral water is the subject of the investigation. Its action on the human system depends upon its inorganic constituents, and it is desirable to possess an accurate knowledge of their nature and quantity. But a water which is intended simply to repair the water-waste of the system should not introduce into it any notable quantity of other matters. There are few waters which do not contain some extraneous substances, such as sodium chloride, lime, magnesia, and iron, and these are probably utilized in the economy, but if no special action is produced by them it is needless to determine with precision their various proportions. On the other hand, where their existence seems productive of special effects, and an exhaustive analysis is deemed requisite, the water containing them loses its potable and assumes the mineral character.

But while the inorganic matter in ordinary waters is of little consequence, provided its total remains within the limit of wholesomeness, it is otherwise with the obscure and intangible organic matter. In one water it may be an innocuous vegetable taint from the wooden vessel containing it, while in others it may consist of the elements of disease, of remittent fever, dysentery, typhoid, cholera, &c.

Recognizing these facts, the attention of investigators has of late years been withdrawn from the mineral to the organic constituents of the water supply. What was formerly brought to the balance in all its individual items is now weighed only *in toto*. What was slurred over as the volatile matters lost on ignition is now closely questioned on every side for evidence as to its quantity, quality, and origin. The organic matter is made the central point to which all investigation tends. It is surrounded by many difficulties, and it remains for the future to furnish means for the definite determination of quantity and the distinct differentiation of quality. At present analysis can only approximate toward the one, and suggest from its increasing experience concerning the other. But imperfect as its results may be considered when viewed from the standpoint of scientific accuracy, it forms the most efficient guard which we possess against the introduction of disease by the water supply. Certain limits of organic impurity have been assigned within which waters have been classified as pure, usable, and dangerous or unfit for use; and although the correctness of these limits cannot be supported by satisfactory evidence in all cases, they have been assigned by those (Frankland Wanklyn, Tidy De Chaumont, &c.) who have devoted years of attention to the subject, and ought, therefore, to be accepted until modified by further research.

Organic matter consists essentially of the four elements, carbon, nitrogen, hydrogen, and oxygen. When heated in the presence of atmospheric air, the chemico-vital tie which binds them together is destroyed, and each, during the process, forms simpler and volatile combinations which are immediately dissipated. Hence the old method by ignition for determining the amount of organic matter. But heat alone suffices to sever the chemico-vital bond, in which case, while the whole of the nitrogen, hydrogen, and oxygen are dissipated, the greater part of the carbon remains, often preserving in a black eschar the form and general appearance of the original material. Carbon, thus seeming to constitute the basis or matrix of the organic tissue, has been viewed as the characteristic element of organic nature. Organic chemistry has, indeed, been called the chemistry of carbon. But there is a higher chemistry than the organic. There is a vital chemistry; and if the former is rightly expressed as the chemistry of carbon, the latter may with equal propriety be set down as the chemistry of nitrogen. There are organic products—products, of course, of vital action—which contain no nitrogen, such as the earthy matters which constitute two-thirds of bone tissue, cellulose, starch, sugar, and fat, but these are either mechanical supports or organic stores for future assimilation. The vital tissues which elaborate them are nitrogenous.

And as carbonic acid is the first step in the advance of carbon towards organization and the last in its decomposition, under ordinary circumstances, so ammonia may usually be viewed as the first and last stages in which the nitrogen of a vitalized organism makes its appearance. From ammoniacal salts the nitrogen of the vegetable world is obtained, forming azotized tissues which directly or indirectly furnish the pabulum for the animal kingdom. The waste and decay of animal life return the element to the simple ammoniacal combination, in which condition it is ready to repeat its history in another generation. The name of *azote*, which was applied to this element, from its passivity as an atmospheric gas, is clearly a misnomer. On the contrary, it would seem to be the chemical element of life—the material *sine qua non* of vitalized action. Organized products may not contain it, but without its presence in more complex tissues they would not have had existence.

Furthermore, the more nitrogen an organic tissue or product contains, the more complex is it, and the greater the possibility of poisonous products being evolved in its decomposition. In the vegetable kingdom most of the powerful poisons contain nitrogen, while among animal products, or the products of their decomposition, there is scarcely a deleterious substance which is not azotized. In viewing the organic matter which may be present in a water, its nitrogen would seem to be the all-important element.

Not only has the nitrogen of existing organic matter to be studied in the sanitary analysis of a water, but all the nitrogen which it contains is of interest as having formed part of a living organism at some period more or less remote.

Ammonia, as being the last stage of the nitrogenous decomposition, or the inorganic result of the destruction of vitalized tissues, is an important item in the analysis. Its quantity must be carefully determined and due consideration given to the value of its presence as bearing on the quality of the water. Ammonia in a rain water drawn from a sound and clean cistern has manifestly a significance differing from that which attaches to its presence in a well-water with a vault or stable within the area of drainage. In the one case it is washed from the house-roof, and is a product probably of coal combustion; in the other it filters through the soil, and is a product probably of the decomposition of animal waste.

The nitrates and nitrites which may be present in a water must likewise be studied as yielding inportant information concerning the quality of the sample. These are frequently formed during the slow resolution of complex nitrogenous materials.

But there are methods of investigation which, without having special reference

to the presence of nitrogen, yield, nevertheless, so much information regarding t organic matter of a water that they must be embraced in the scheme of analys The sanitary interests involved in a question of doubtful water supply are too imp tant to warrant an official decision without a careful consideration of *all* the eviden procurable. Of these methods, that by ignition, the old process, must not be ov looked, while an estimation of the quantity of oxygen required by the oxidizab matters in the water often throws light on their character when received *per se* or connection with other analytical results.

All organic material has a proportion of inorganic matter involved in its chemic vital constitution. These inorganic substances are various, but one salt, sodiu chloride, is of special interest to the water analyst. It is the salt of the anim economy, present in all the excretions and liberated in all the decompositions. It found in all natural waters, and its quantity is sometimes a chief witness in cases suspected contamination.

Microscopic examination is valuable as corroborative of the findings by the chemic evidence. No analysis should be deemed complete which does not comprise an inve tigation of the sediment by its means. The sediment of every water is complex an would repay continued study, but there are general characters which can be seen at glance. The few mineral particles and still field of a pure well water is wholly diffe ent from the active life which appears in a water charged with vegetable impurit and the living forms in characteristic specimens of the latter are markedly differe from those which are discovered in water where the contamination is of animal origi

The experimental results of the investigations indicated cannot be summed up an expressed as an opinion on the quality of the water. The history of the sampl must be known and the results weighed in connection with it. This may appear as formal acknowledgement of the valuelessness of the various processes. But a moment thought will serve to realize that each variety of potable water has an average const tution. A rain water in its dissolved matters differs materially from a spring wate on account of the difference in its antecedent history. The amount of chlorine, fo example, which might exist in the spring without prejudice to its wholesomeness woul suffice to condemn the stored rain water of an underground cistern, while the ammonia as already instanced, which might mean little in the rain water would in the sprin be suggestive of dangerous contamination.

The sanitary analysis of a water is thus seen to consist of:

1st. A determination of the *total solids*, for the purpose of ascertaining whether th sample comes within the limits of potability, with incidental observations on the gen eral character of the inorganic salts.

2d. The *loss* suffered by the total solids *on ignition*, as affording a view of the organi matter *in toto*, and possibly a further insight into the character of the saline constitu ents.

3d. An estimation of the quantity of *oxygen necessary* to *oxidize* the *oxidizable matter present* in the water, as affording a view, when taken in connection with other experi ments, of the organic matter on its carbonaceous side.

4th. An estimation of the *amount of ammonia* which can be obtained as the last stag in the destruction of the *organic matter present*, as giving a view of the said organi matter from its nitrogenous side.

5th, 6th, 7th. Determinations of the *ammonia*, *nitrous* and *nitric* acids, as indicatin the amount of organic matter which may have been present in the water at a *perio more or less remote*, and defining the period when viewed in conjunction with other con siderations.

8th. A determination of the *chlorine* present, as bearing on sewage contamination

9th. The examination of the *sediment by the microscope*, as yielding corroborative evi dence as to grade and kind of impurity.

10th. A study of the *source* and *surroundings* of the *water supply*, in connection wit the results of the investigations above enumerated, to furnish a proper appraisemen of the value of the said results.

SECTION II.

PRELIMINARIES.

To permit of the performance of all the experiments which are included in a sanitary analysis, half a gallon of the water is necessary. Less may answer, provided that ni trates are absent; but as this cannot be ascertained until the investigation is in prog ress, it is well to decline the examination, unless the quantity which may be needful has been furnished. To afford satisfaction to the operator by the self-consistency of his results, all his experiments should be made on the same sample. Water supplies are not identical in constitution from day to day. The character of a cistern water is changed by every influx from the roof. The constituents of well waters fluctuate. In shallow wells they are lessened in wet weather; in deep wells and springs, although

less changeful, they are not fixed quantities. In rivers the rise and fall alter the proportion of the solids to the containing water, and, as now one tributary and again another becomes the source of flooding, the proportion of the solids to each other is altered. Suppose the nitrites in a leaky cistern have been determined, and that the operator, having been on short allowance, has to obtain another supply for the esti mation of nitrates; it is possible that a change by dilution may have taken place in the meantime, and that the nitric acid in the second sample may be insufficient to account for the nitrous acid of the first. The existence of nitrates in the case cannot be determined, and so far as they are concerned, the work done is valueless. So the nitrogenous view of the organic matter in one specimen is not comparable with the carbonaceous view obtained from a second, except on the assumption, which cannot be warranted, that no change has meanwhile taken place in the character of the water.

Great care is required that the water furnished be a fair sample of the supply to be investigated. It may seem trifling to insist that the specimen should be collected in clean bottles, but in practice it will be found needful to dwell upon this point. A gentleman much interested in water supplies, intelligent, and careful, presented a sample in a wickered demijohn for examination. It had been collected by himself with all proper precautions. Torula cells were found in the sediment, which led to the discovery of a rotten cork still odorous from its connection with the alcoholic fermentation. A sample of water forwarded for analysis in a stone jug was declined, as its analysis would have resolved itself into a determination of how much lager beer was contained in the vessel at the time the water specimen was introduced. Stone jugs, wickered demijohns, and dark-colored glass should be inadmissible, unless the analyst is himself the collector. Clear glass bottles which show their quality of cleanliness at a glance should be selected. They must be rinsed out several times with water from the source which is to furnish the sample, and the corks used should be new and sound. Glass-stoppered bottles are preferable.

But a water-supply may be misrepresented by its sample in a less obvious manner. Thus, a well-water in Grenada, Miss., was found to be of bad quality. As other wells in this vicinity contained good water, its impurity was conceived to be of local origin. On investigation, there appeared no cause for the inferiority in quality until it was discovered that a new pump had been inserted on the previous day, and that the water had been rendered less clear than usual by the disturbance incidental to the work. The sample furnished under these circumstances did not fairly represent the water-supply from that well. Analysis enables one to pronounce upon a water only as it existed at the time the sample was collected. If accidental circumstances rendered it impure at that time, no inference can be drawn as to its condition under ordinary circumstances. Hence, if the sample is intended to illustrate the character of the supply under the conditions which ordinarily obtain, it should be collected under those conditions. But if these are subject to irregular or seasonal alterations, as is the case with river waters, the value of the analysis is necessarily restricted.

The label of each bottle should state all particulars which bear upon the quality of the contained water, or a mark for identification may be placed upon the label and the particulars given in a letter of transmittal. The information furnished cannot be too full.

In the case of raised tanks or cisterns, in addition to the locality there should be stated the capacity of the cistern and the material of which it is constructed; whether provision is made for covering, shading, and ventilating it; its age, and length of time since last cleaned; whether there is much or little water in it; the material of the roof which supplies it, tin, slate, shingle, &c.; whether any special effort is made to insure purity, as by the use of a cut-off, an accessory or sedimentary cistern, or some process of household filtration; whether there are any sources of impurity in the vicinity which might affect the supply, as the proximity of gas works, &c., whether any character of unwholesomeness has been imputed to the water, and whether the sample represents the supply in its best, worst, or average condition.

In the case of underground cisterns there should be noted the material and depth of cistern, with depth of the contained water, material of roof, possible sources of aerial contamination, proximity of stables, water closets, or privy vaults, with the level of the contents in the last in relation to the water level of the cistern, character of surface and subsoil drainage, age and condition of cistern, and other points as mentioned in connection with the supply in raised tanks.

With respect to wells, the depth of the well and of its contained water should be given together with all particulars concerning the drainage into it. The proximity of large trees is a point which should invariably be noted.

In spring waters the probable source of the supply and possible sources of contamination should be enumerated. These waters are often tainted by admixture with surface washings which the expenditure of a little labor could easily prevent. The proximity of cemeteries should always be stated and the probable direction of their drainage.

River samples should have mentioned with regard to them the exact point from

which they were derived and the distance of this below such sources of impurity as are constituted by sewage inflow and manufactory refuse. The stage of the river is also important, as the turbidity which increases with a rise in the water level adds correspondingly to the impurity.

In entering these particulars on the laboratory record, a note should be appended as to the physical characteristics of the water. Pure water is colorless, at least as seen in the clear quart or half-gallon bottles in which it is submitted to the analyst. Some operators make use of a long tube through which the color of a reflected white light is observed, but this is needless, as all that can be learned by such observations can be got at more definitely by other processes. Water which contains vegetable matter has frequently a tinge of yellow. But various grades of turbidity are more common than color alterations. These range from a simple loss of luster through various degrees of haziness and cloudiness to well defined turbidity from particles individually visible. The water may often appear to be altered in color by the color of its suspended cloudiness. Carbonaceous matters in cistern water darken the sample. Clay gives frequently a rusty or dark colored haze in well and river specimens. Note should be taken of the presence of water-fleas, larvæ of insects, or other visible impurities. The odor of the water is also to be observed. Well waters turbid from clay have sometimes a bad odor depending on the decomposition of sulphides, but the water may not necessarily be unwholesome. Some good wells in Duckhill, Miss., are thus affected. The odor of vegetable matter can frequently be determined in the sample. The decomposition of sulphates in the presence of vegetable organic matter may communicate a sulphuretted taint to the water.

The water sample should be subjected to analysis as soon as received. Changes may take place in it destructive of the evidence which it is the object of the analysis to educe. For example, the trace of ammonia, which in a deep well-water testifies to the entrance of surface impurities, may be lost by the development and growth of vegetable spores. Dissolved organic matter may be destroyed by its prolonged contact with the oxygen which may be present in solution, or it may be removed by infusorial growth which transfers it to the bottom of the bottle as an organic sediment. The instances where deterioration results from keeping must be very infrequent, but not so those in which the sample gives a better character to the water than would have been warranted by the examination of a freshly drawn specimen. Deterioration may occur in waters which have much organic sediment when they are kept at a temperature higher than that which prevailed at their source. If the period elapsing between the collection and examination of a specimen exceeds a few days, their number should be specified as a part of the analytical record.

When a water which is more or less turbid is permitted to stand for a few hours, a precipitation takes place of the suspended matters which constitute the turbidity. The heavier and grosser particles settle first, leaving above them a cloud or haze of the lighter and finer particles with a stratum of clear water over all. Ultimately the haze settles and the whole of the water is clearer and purer than it was when freshly drawn. The solid mineral particles in their precipitation entangle and carry down the fine organic *débris* which may have been suspended. In an ordinary sanitary analysis the whole of this sediment is to be shaken up and redistributed in the water. The object of the examination is to determine the character of the water as drawn for a water-supply, and the contents of the sample bottle, whether clear or turbid, should represent the supply as used by its consumers. If the clear water from a sedimental sample is examined, the analysis will not show the quality of the water consumed, but its quality as purified by an efficient process of sedimentation. It may be of importance to know this—in which case operations have to be conducted on both the turbid and sedimented waters—but if the question at issue is the condition of a given water which is truly represented by its sample, all the constituents of that sample in their naturally existing proportions must be included in the examination.

The weights and measures used are those of the metric system—grams and cubic centimeters. A gram is a weight equal to that of a cubic centimeter of distilled water when at its maximum density; the centimeter being the hundredth part of a meter, and the meter the ten-millionth part of the distance from the equator to the pole. One thousand cubic centimeters are one liter. In dealing with volumes of water, however, we are frequently confronted with other expressions of measurement such as cubic inches and the U. S. and imperial gallons.

1 liter = 15,432.328 grains = 61.027 cubic inches = .26 U. S. and .22 imperial gallon.

1 U. S. gallon = 58,372.175 grains = 231 cubic inches = 3.785 liters = .833 imperial gallon.

1 imperial gallon = 70,000 grains = 277.274 cubic inches = 4.543 liters = 1.2 U. S. gallons.

In the experimental work of analysis various quantities of water are operated on. In one case, where the quantitative test is of greater sensitiveness or the substance to be determined exists in larger quantity, a small volume of the water may suffice for the determination. In another, where the test is less sensitive or the substance in

smaller quantity, a larger volume may have to be employed. On this account it becomes necessary to express the results by ratio as in other matters we speak of percentages to insure a better appreciation of the statement. In the analyses on which this report is based, the expression of results is in parts of the substance estimated in every 100,000 parts of the water under examination. This mode of statement has been adopted because it appears to be growing in favor among analysts; and in order to admit of ready comparison between the results of different operators, it is advisable that one mode of expression be adhered to. Milligrams per 100 cubic centimeters are synonymous with parts per 100,000.

In conversing with individuals who are unaccustomed to the technical expression it may be necessary to render parts per 100,000 into grains per gallon as the latter satisfies inquiry more efficiently by the sense of absolute quantity which it embodies. Multiplication by .58372 converts parts per 100,000 into grains per U. S. gallon; by .7 into grains per imperial gallon.

SECTION III.

ON THE TOTAL SOLIDS AND THE LOSS ON IGNITION.

The total amount of the dissolved solids in a water is obtained by driving off the water at the boiling temperature and weighing the residue. It is not necessary to employ more than 100 c. c. of the water for this experiment. If a larger quantity is used, on the ground that the error in weighing will be proportionally lessened, it will be needful either to evaporate in a larger disk than can be brought to the balance or to prolong the evaporation in a small disk by repeated additions of the water until it is all dissipated. In the former case there will be a loss during the transfer to a smaller dish; in the latter the continued ebullition may be destructive of organic matter, while atmospheric dust may add unauthorized weight to the water residue. The accuracy which is theoretically gained by operating on a larger quantity may be lost in practice by the circumstances attending the larger operation. Besides, 100 c. c. usually present a very tangible residue. Seldom, even in the examination of rain-waters, is it needful to employ more.

The evaporation is conducted in a platinum dish over a water-bath, the contents of which are kept boiling vigorously, in order to have no unnecessary prolongation of the exposure. The dishes used in the experiments recorded in this report were 3 inches in diameter, and weighed from 39 to 47 grams. Their small size saved the balance but rendered them incompetent to hold the 100 c. c. at one charge. They were filled at first and after the evaporation had proceeded for some time, the remainder of the charge was added. It is advisable to leave the platinum dish on the bath for ten minutes after all the water has disappeared, in order to insure a thorough drying, as organic matter is usually tenacious of moisture.

The dish is then removed and its exterior wiped with a clean absorbent towel. As soon as it has lost its excess of temperature, it is placed on the pan of the balance and weighed. The weighing must, of course, be performed with as much accuracy as the balance will permit, for, although in the matter of total solids it may be of little account whether there are 20 or 21 milligrams in the dish, unless this point is accurately settled, the loss on ignition, to be subsequently determined, cannot be obtained. The known weight of the dish having been deducted from the weight found by the experiment, the result is the amount of the total solids in the quantity of water evaporated, but since 100 c. c., which contain 100,000 milligrams, were employed, the weight of the residue in milligrams is the total solids of the water expressed in parts per 100,000.

The balance should be placed on a firm and level stand in a room free from draughts, and with a northern exposure, so that heat rays may not impinge on any of its parts. Accurate adjustment is essential, and if any one has been near the instrument since it was last in use by the operator, its condition should be inspected before any process of weighing is undertaken.

The appearance of the residue often gives information concerning the inorganic matters present. Lime carbonate is deposited over the whole of the interior of the dish from the original level ot the water which was contained in it. Lime sulphate thickens the white coating towards the bottom, and if it is present there are no alkaline carbonates among the more soluble salts which the water has left in a crystalline crust in the bottom of the capsule. They are probably chlorides, sulphates, or nitrates.

The platinum disk is now placed upon a support and the Bunsen flame is passed along its exterior so that every part of it may be brought to a dull redness. Water of crystallization is dissipated from the salts which contain it, such as the sodium and magnesium sulphates, leaving them crisped and effloresced. Ammoniacal salts are volatilized. Lime sulphate becomes anhydrous. Organic matter is charred, and if small in quantity, gives a faint darkening of the inorganic film, which is entirely removed by a continuance of the heat. If it is present in larger quantity the film may become streaked with concentric lines of darker color, which require a longer exposure to the

flame before they disappear. In highly organic residues the blackening is deep all over the interior, empyreumatic fumes arise, points of ignited carbon make their appearance, and, if nitrates are present, the energy of the combustion may be much increased and nitrous fumes detected in the vapors. Lime carbonate may suffer some loss during the ignition. Lime sulphate may be in part reduced to sulphide by the carbon of the organic matter. Magnesium chloride if present loses its chlorine and becomes represented by the oxide. But the heat should never be so great as to cause loss to the sodium chloride.

The dish is now permitted to cool and the film is moistened with a few drops of ammonium carbonate solution to recarbonate any lime which may have been reduced. The water and volatile alkali are then dissipated by a gentle reapplication of the flame, the dish is removed to a good conducting surface to cool, and when cold it is again weighed. The difference between this weight and that previously obtained is the weight of the various substances lost on ignition; the difference between it and that of the platinum capsule is the weight of the inorganic residue. The laboratory note book records the experiment thus:

$$\begin{array}{lll} & 39.3425 \text{ after ignition.} & \\ 39.455 \text{ total weight.} & -.217 \text{ capsule.} & \\ -.217 \text{ capsule.} & & \\ \hline .238 \text{ total solids} = & \left\{ \begin{array}{l} .1255 \text{ inorganic residue} = \\ .1125 \text{ dissipated.} \end{array} \right. & \left\{ \begin{array}{r} 125.5 \\ 112.5 \\ \hline 238.0 \end{array} \right\} \text{ parts per 100,000.} \end{array}$$

It must not be forgotten that by continued use in these experiments the platinum capsule is liable to lose weight. To avoid error from this source its condition should be closely watched and its recorded weight amended when necessary.

After the weight of the inorganic residue has been taken, a few drops of distilled water are added to it and the process of solution observed. The soluble salts, chlorides, carbonates, and sulphates disappear, while earthy carbonates and lime sulphates, silica, and clay remain undissolved. The liquid in the capsule is poured into a small filter and a drop of the filtrate permitted to fall on a piece of red litmus paper; a blue stain shows the presence of sodic or potassic carbonate. A second drop deposited on a glass plate is brought in contact with diluted hydrochloric acid; effervescence confirms the presence of these soluble carbonates. A third drop is touched with a glass rod which has been dipped in a solution of baric chloride acidulated with hydrochloric acid; a whitish turbidity indicates the presence of sulphates.

The filter is thrown aside, and a little diluted hydrochloric acid is added to the residue in the platinum capsule. As it is made to flow over the film of earthy matter, a wave of effervescence attends the destruction of the lime carbonate. The insoluble turbidity is lime sulphate, clay, and silica. The sulphate is dissolved by the addition of water,—the clay adheres to the sides of the dish and is removed with difficulty,—the silica settles as an insoluble sediment.

These observations occupy but little more time than is necessary to cleanse the capsule before laying it aside, but when the results are considered in connection with the chlorine and nitric acid estimations which are essential parts of the analysis and with the total solids as already found, a satisfactory appreciation of the character of the inorganic constituents of the water may often be obtained.

The quantity of total solids which is compatible with potability depends primarily on the amount of the included organic matter, and, so far as it is concerned, the wholesomeness of the sample will be decided by the results of the organic analysis. With respect to the inorganic residue, the quantity will depend on the nature of the substances. According as sodium chloride, carbonate and sulphates of the alkalies, lime salts or those of magnesia predominate in the water the greater will be the tendency of equal qualities to produce effects incompatible with potability, and the less the total amount which will define the limit of wholesomeness. But practically the question is often solved without reference to these considerations. Well, river, and spring waters which contain less than 30 parts of inorganic residue, have not been charged by experience with the production of any specific effects, no matter what their constitution, unless their taste has indicated the possession of mineral qualities, in which case the question of their potability is never at issue. If the water under examination contains less than 30 parts, it may therefore be reported as wholesome so far as its inorganic constituents are concerned.

On the other hand, if the sample contains 100 parts, it may be unhesitatingly condemned as unfit for use, no matter what the itemized list of its salts. The use of such a water may not be followed by strikingly evil effects, such as intestinal fluxes or diuresis, but ingestion necessitates elimination, and this cannot be accomplished without a call upon the vital energies, which in time may become impaired. Nature herself appears to pronounce against waters so charged with inorganic salts, by giving them a taste which renders them less palatable as the amount increases.

For waters which range between 30 and 100 parts, a report based simply on the total

should characterize them as more or less doubtful, according as it approaches one or other of the extremes. It must be remembered, however, that if an organized supply for a large community is under advisement, the inorganic constituents of the water should not exceed the limit of assured wholesomeness, or, if financial considerations impose an inorganically doubtful water for investigation, its use should not be authorized without a close scrutiny of the evidence in its favor. The insight obtained incidentally into the nature of the inorganic salts may enable the analyst to report with greater precision in doubtful cases, but usually the question of wholesomeness is decided by collateral evidence. The test of experience has no doubt been applied to them, and inquiry will either prove their harmlessness or develop the suspicions which have been entertained against them. The sense of taste objects to many magnesian, lime, and alkaline waters, even when the total of inorganic matter does not reach 100 parts. The hardness or softness of a water, as roughly determined by the use of soap, is also suggestive in forming an opinion as to its inorganic quality. The sample may be condemned if the soap curdles much and refuses to form a lather, and especially if this is the case after the water has been boiled.

The soap test is so useful in affording an approximative estimate of the earthy salts that it was proposed to have it included among the analytical processes to be employed in the examinations herein recorded. But further consideration appeared to show that all hygienic inquiries might be answered by an intelligent study of the water residue. This test was therefore omitted from the scheme, but as its results are frequently expressed in the statements of water analysis, a short account of the method of its application may be of use.

When a strong solution of soap is added to pure distilled water, a lather can readily be formed on agitation, but if lime or magnesian salts, free carbonic acid, or iron are present, the soap becomes decomposed and a lather will not form until all the interfering substances are precipitated. The reaction which takes place is definitely quantitative. A certain quantity of lime, &c., in the water requires its equivalent of soap for its removal. The soap solution thus becomes a measure of the earthy salts in the water, while the occurrence of the lather simply indicates the conclusion of the measurement.

A solution of potash soap is made in equal parts of alcohol and water, and its strength is determined by experiment on a standard hard water, that is, on a water containing a known quantity of lime as carbonate. A certain quantity, say 100 c. c., of the water is put into a bottle capable of holding as much again. A little of the soap solution is dropped in from a burette and the bottle is stopped and shaken vigorously. The water clouds and bubbles may form on the surface, but they immediately break. The addition of soap solution and the subsequent agitation are repeated until a uniform beaded film is obtained which will remain unbroken for five minutes. The quantity of soap used is now read from the burette; but as this includes not only what was necessary to precipitate the lime, but also the amount needful to produce a lather in 100 c. c. of the water, a second experiment has to be performed on an equal quantity of recently-boiled distilled water in order to determine how much has to be placed to the account of the latter reaction. The result of this second experiment deducted from that of the first gives the quantity of the soap solution which is required to precipitate the lime present in the 100 c. c. of standard hard water. By dividing the weight of the lime carbonate by the number of cubic centimeters of soap solution used, the equivalent in lime carbonate of 1 c. c. of the test solution is obtained.

To determine the hardness of a given water, 100 c. c. are treated with the soap until the beaded film is produced. The quantity necessary to the production of the film in this measure of pure water is deducted from the total soap used, and the result is the number of cubic centimeters of soap solution required for the precipitation of the lime. But the value in lime carbonate of 1 c. c. of the test solution is known. Hence, by multiplying that value by the number of cubic centimeters, the amount of lime carbonate is found which was present in the quantity of water employed. Milligrams per 100 c. c. are synonymous with parts per 100,000. These parts are multiplied by .7 to express the result in grains per imperial gallon, or, which is the same thing, in degrees of hardness of Clark's scale, each degree being equivalent to the presence of 1 grain of lime carbonate in the gallon of water. A hardness of 16° indicates the existence in a water of substances which act upon soap as if lime carbonate were present in the proportion of 16 grains per gallon.

Hardness is usually referred to as total or permanent. That obtained by the above experiment is the total hardness of the sample. To ascertain the permanent hardness, 100 c. c. of the water are boiled for half an hour in a flask. When cool, the loss which has occurred by evaporation is replaced by distilled water, and the soap test is applied. During the boiling, carbonic acid is dissipated, iron and the greater portion of the lime carbonate are thrown down, so that the soap used in this case indicates the hardness from lime salts unaffected by the boiling, such as the sulphate, chloride, and nitrate, and from those of magnesia. This is the permanent hardness.

A good water for a drinking supply should not have more than 16° of total hard-

ness. A permanent hardness of a very few degrees unfits a water for domestic use. When an estimate is made of the soap lost by a community in neutralizing a hard water, the advisability of soft water for a general supply is manifest.

As the quality of hardness is caused chiefly by the presence of earthy salts, it does not follow that all waters are hard which have a large amount of total solids.

The total of inorganic salts in a water depends upon its antecedent history. Rain water in its precipitation from the clouds carries down but a trace. The same water, in its course over a roof to be collected in a cistern, has the trace increased to 2 or 3 parts. Rain water is often said to be very pure, the expression being intended to convey an idea of the comparatively small amount of solids dissolved in it. But the use of the word pure in this connection is injudicious. It is true that the water which contains 2 parts of dissolved solids is purer than that which contains 20 parts, but this only in a chemical sense. People do not appreciate this technical restriction on the value of the adjective, and very generally they accept the statement in a sanitary sense. Pure is conceived to be synonymous with wholesome, and much confusion of ideas is induced. This, while appearing on the surface as a small matter, a question only of words and ideas, is sometimes fraught with important sanitary interests. Wolf River water, which constitutes the organized supply of the city of Memphis, Tenn., has been stated by chemists as a pure water, since it was found to contain less inorganic solids than the average of rivers, and thousands of people have been drinking and are drinking its foul waters on the strength of that statement.

The rain water which falls upon the soil and is drained off by surface channels into ponds, lakes, and rivers, obtains an increase to its total solids proportioned to the solubility of the soil. Where the surface is formed by the older rocks the water may continue free from mineral matters. The Little Wind River, at Fort Washakie, Wyoming, has only 2.3 parts. But usually the soil presents some constituents which are acted on by the water, and which add to its dissolved solids. The total solids in the following streams are given as illustrative of what is generally found in the running waters of this country. They were determined in the clear water after sedimentation.

	Parts per 100,000.
Douglas Brook, Salt Lake City, Utah	24.6
Beaver Creek, Fort Cameron, Utah	8.0
Lodge Pole Creek, Sidney Barracks, Nebr	13.1
White River, Fort Robinson, Nebr	18.7
Loup River, Fort Hartsuff, Nebr	14.6
Crow Creek, Fort Russell, Nebr	15.6
Laramie River, Fort Laramie, Wyo	20.0
Black's Fork, Fort Bridger, Wyo	8.2
Platte River at Fort Steele, Wyo	10.9
Platte River, Fort Fetterman, Wyo	14.3
Platte River, Fort McPherson, Wyo	12.7
Wolf River, Memphis, Tenn	12.5
Mississippi River, Memphis, Tenn	20.0
Mississippi River, New Orleans, La	21.0
Potomac River, Washington supply	12.0

All these waters are wholesome, as respects inorganic salts. That of the Douglas Brook is somewhat hard, 9°.3 of permanent hardness, due chiefly to lime sulphate, but observation on the use of the water, continued for many years by army medical officers, has failed to bring any suspicion of unwholesomeness against it.

The rain water which sinks into the soil to form part of the ground water of the locality, or to be drained off along the surface of inpermeable layers, has better facilities for dissolving mineral matter, and accordingly it may be stated in general terms that such a water, appearing naturally as a spring or draining into a well or other underground reservoir, will contain more solids in solution than pond or river water. Salts of lime and magnesia, of potash and soda, appear in varying totals, and in varying proportions in the total, according to the constitution of the soil through which percolation has been effected. If the earthy salts predominate, objection may be made to the water, even though the total be but little over 30 parts; but if the water have more of a saline character, the solids may approach 100 parts without suggesting more than a doubt, which is to be removed or confirmed by other evidence.

Spring or well water, however, which is filtered through a clean sand, may contain but a small proportion of inorganic salts. A well at Holly Springs, Miss. (Buchanan's Analysis, 177), has only 1.5 parts. The hydrant supply of Mobile, Ala., which is brought from springs six miles distant from the city, has but 7 parts. These are rain waters filtered through sand which has added but little to their total solids.

On the other hand, if the filtration is effected through a soil charged with soluble salts, the dissolved solids may be largely increased. A spring at Holly Springs, Miss., contains 31 parts; a well at Jackson, Miss., has 90 parts, chiefly lime carbonate; while one at Brandon, Miss., gives 182 parts, mostly consisting of lime salts.

The amount of solids in a water does not necessarily increase with the depth of the stratum which contains it. Springs from the older rocks are comparatively free from inorganic salts, and deep wells often give but a small amount of total solids. Shallow wells in ground which has been long occupied as town sites, and which has become contaminated in consequence, frequently contain large quantities of inorganic matters. The well, 27 Main street, Memphis (Analysis 222), contains 217 parts, and another at 42 Winchester street (Analysis 185), in the same city, 238 parts, consisting of nitrates and chlorides infiltered from the surface, and of earthy salts from the soil proper.

Although the limit of undoubted wholesomeness is not passed until the water contains more than 30 parts, there are certain cases where less than this quantity will suffice to condemn the water, not from any specific action of the salts, but from other contaminations which are indicated by their presence. Thus, 30 parts of solids in the water of an underground cistern are suggestive of leakage from the soil into the reservoir, and if the soil is known to be polluted the water must be bad. The leak which admits the inorganic matter must admit the more dangerous constituents of the impure soil. Rain water shed from a roof contains from 2 to 5 parts. Cistern waters which contain more than this must have obtained their increase while stored. A slight increase, say a total of 10 parts, may be derived from the action of the water on the cement lining of the reservoir. Calcic carbonate is present in the residue. This, while important in connection with the durability of the cistern, has no bearing on the quality of the sample under examination. But any increase over 10 parts is probably due to leakage, and necessitates close inquiry into the quantity and character of the inflowing impurities. The leak in some cisterns may be so great that the water ceases to be a cistern water, and must be viewed and judged as if it had been drawn from a shallow well. A so-called cistern water at 150 Monroe street, Memphis (Analysis 149), yielded the largest amount of total solids of any water embraced in this report, 325 parts.

Cisterns in which river water has been stored at some previous date cannot have leakage established against them by a slight increase in the total solids of their contained water. The increase may arise from a residuum of the river water. One case occurred in which a large proportion of solids was due to the introduction of common salt as an antiseptic or preservative at the commencement of the yellow-fever season. The possibility of such cases induces caution in arriving at conclusions. An excess of solids in a cistern water implies the presence of soluble matter, the derivation of which must be ascertained. It may have come from the lining of the reservoir; it may have been introduced intentionally; or it may have been derived, as is usually the case, from the soil by leakage.

Where a number of wells in the same vicinity have been examined, a variation in the quantity of their total solids is often indicative of the quality of the water. An increase is probably connected with contamination from local causes. In Mobile, Ala., there are two series of wells, shallow and deep; the former contain surface water imperfectly filtered and organically unwholesome, with from 70 to 120 parts of solids; the latter contain water of a different origin, wholesome in character, and with from 6 to 20 parts of inorganic salts. Here a simple determination of the total solids will show the derivation and probable quality of a given water, while, if the well which furnished it is known to be deep, an increase in the total will indicate contamination by inflow from the overlying strata.

The loss which the solids suffer on ignition depends, as has been said, on the dissipation or decomposition of particular substances, such as nitrates, carbonates, sulphates, ammonia, water of crystallization, water of constitution, hygrometric water, and organic matter. The carbonic acid may be replaced before weighing, but this correction does not indue the result with value as an expression of the organic matter present. The substances, any or all, may exist in such varying quantities in the residue that the loss of weight can only be accepted as indicating their total. Frequently the organic matter constitutes but a small proportion. The well water at 160 Saint Martin street, Memphis (Analysis 207), lost 17 from a total of 38.5 parts, chiefly on account of dissipated water. That on 27 Main street lost 78 parts from a total of 217, principally owing to the reduction of nitrates. A water from a Brownsville well lost 38 parts from its total of 70 on account of organic matter and hygrometric water. In cases of this character the organic loss is an unknown quantity. Nevertheless, statements are current concerning organic matter which would lead one to suppose its weight susceptible of accurate determination. So many grains of organic matter per gallon are said to render a water unwholesome. So many grains per gallon cause a blackening or ignition. Very probably so in both instances; but the statements are misleading. If the organic matter could be isolated on the pan of the balance, the sanitary analysis of a water would be effected by a different method from that now in use. But, unfortunately, this cannot be accomplished. If we examine the residue of waters which contain nothing but organic matter for the heat to destroy, the worthlessness of deductions from the loss of weight is at once apparent. The rain water of the raised cypress-wood tanks of New Orleans, La., contains traces of

ammonia and of nitrates and sulphates, but they are insufficient to cause a loss appreciable by weight. The solids in its residue, which are destroyed by ignition, consist practically of organic matter. The loss in forty-one residues varied from 1 to 5 parts. In one instance 6 parts were lost, but this water contained ammoniacal salts in unusual quantity, and it is therefore excluded from present consideration. The usual loss amounted to 2 or 3 parts. But the purity of the water, as determined by further examination, bore no relation to the amount of loss. Indeed, the water (Analysis 17) which gave 5 parts of so-called organic matter was a purer specimen than that (Analysis 30) which gave but 1 part. The samples could not be graded by their loss on ignition. The cause is obvious; although there are no nitrates or other salts to complicate the case, there is water to be dissipated, and organic matter is tenacious of moisture. Results more consistent with the character of the water might probably have been obtained had the residue been dried at a higher heat, or had the drying in the water-bath been prolonged; but, as the experiment is ordinarily performed, the loss in the total solids by ignition is valueless as an expression of the organic matter present.

The loss of weight leads, however, to an examination as to its cause; and when the action of the heat upon the residue is carefully observed, there is usually no difficulty in forming an opinion which will be corroborated by subsequent investigations.

So far as organic matter is concerned, the blackening during the process is of more interest than the mere loss of weight. No matter how few parts are lost, if the lining of the capsule blackens all over and the carbon is afterwards dissipated with difficulty, the water is to be viewed as suspicious. In six samples of the cistern waters referred to above, in which the record shows the blackening to have been worthy of special mention, the subsequent analyses indicated the waters as unfit for use. Where fumes are evolved during the combustion, the water is undoubtedly bad. If there is no blackening, or at most a darkening of the residue which is easily dissipated by a continuance of the heat, we are probably dealing with a good water. But this testimony as to wholesomeness must not be accepted as decisive. Further examination is necessary to establish so important a point. On the other hand, if the blackening or fumes testify against it, there is, in the majority of cases, no need for further investigation. What are called peaty waters here constitute the exception. They are dark-colored waters, which experience has shown to be harmless, although containing a large proportion of vegetable matter.

The knowledge of the character of a water obtained by an intelligent determination of the total and fixed solids is thus seen in some cases to comprise all that is requisite for sanitary purposes. The wholesomeness or unwholesomeness of its inorganic constitution can be predicated, and the existence of organic matter in sufficient quantity to condemn the sample can be determined. Cistern and river waters, and those of springs and wells in closely-built localities, where the organic pollution is probably owing to animal waste, may be denounced on the authority of this one experiment. In spring and deep-well waters where the total is small, the loss inappreciable, and the carbonization nil, or sufficient only to give a fleeting discoloration, a favorable opinion may, with equal certainty, be warranted; witness, for example, the almost pure water of a well at Holly Springs, Miss. (Analysis 177.) But in the great majority of instances we have to deal with waters which occupy the debatable ground between organic purity and the rank impurity which can be so easily detected. For discriminating in these cases, other and more delicate tests have to be applied.

SECTION IV.

ON THE PERMANGANATE DECOLORIZATIONS.

The organic matter which has been seen and roughly estimated by the blackening which attends its decomposition consists essentially of carbon, hydrogen, nitrogen, and oxygen. Carbon exists usually in large proportion. Nitrogen and hydrogen are present in smaller quantities. Oxygen occupies a middle place. Thus in the vital or nitrogenous matter of both the animal and vegetable kingdoms, in albumen, fibrin, gluten, casein, &c., we find combined, with 1 part of hydragen, a little over 2, 3, and 7 parts of nitrogen, oxygen, and carbon, respectively. In organic matter of animal origin occurring in a water residue the carbon is to the nitrogen as $3\frac{1}{4}$ or less to 1; and although the same is true with regard to the nitrogenous matters of vegetable life, these are so often mixed with non-nitrogenous products that organic matter of vegetable derivation has its relative amount of carbon very much increased.

But whatever the proportions in which these elements are present in a complex organic substance, every atom of carbon and hydrogen may be made to undergo a thorough combustion or oxidation, and every atom of nitrogen may be recovered in the elementary condition. On this is based the ordinary or combustion process for the estimation of these elements in organic substances. The carbonic acid is carefully collected, and its volume is an index of the carbon present. The nitrogen evolved is

a measure of the nitrogen of the organic matter, and the hydrogen is obtained from the weight of water produced by its oxidation. The oxygen of the substance is expressed by the difference between its known weight and the ascertained weight of its other elements.

But this process for the ultimate analysis of organic compounds cannot be applied in its entirety to the water residue. We have seen the impossibility of arriving at the weight of the organic matters; hence their contained oxygen must remain unknown. Hygrometric water cannot be dissipated without injury to the original material, and the hydrogen estimation is untrustworthy in consequence. But carbon and nitrogen can be determined in this way, and the process of Frankland and Armstrong—the combustion process—has been and is much used in water analysis.

A certain quantity of the water, depending on the probable amount of organic impurity, is evaporated to dryness with special provisions to prevent access of organic dust from the atmosphere, to fix the free ammonia, the nitrogen of which is estimated along with that of the organic matter, and to eliminate the nitrogen of nitrates and nitrites which are not included in the determination. The addition of atmospheric dust is prevented by a bell-glass over the evaporating dish resting on a gutter to conduct away the condensed water, and by an arrangement for the automatic feeding of the evaporating capsule. Ammonia is fixed and nitrogen salts destroyed by sulphurous acid added to the water sample; but a loss of ammonia necessitates a corresponding correction in the ultimate nitrogen results. The evaporation ordinarily occupies twenty-four hours. The residue is then mixed with oxide of copper and transferred to a combustion tube which is attached by an air-tight joint to a Sprengel's pump. The fall of mercurial globules carries the air out of the apparatus. When the exhaustion is perfect, heat is applied to the combustion tube and the evolved gases are collected by the pump over mercury. They are then transferred to an accurately graduated measuring apparatus. The gases are carbonic acid, nitrogen, and nitric oxide. The first is absorbed by the introduction of potassic hydrate, and the diminution in volume measures its quantity. A little pyrogallic acid is then introduced to absorb any oxygen which may have been liberated from the copper oxide. If oxygen is present the residual gas is nitrogen; but if oxygen is absent a few bubbles of this gas are sent into the gas receiver to peroxidize the nitric oxide, the peroxide produced being removed by the pyrogallate of potash. The gaseous residue is now nitrogen. From the volumes of the carbonic acid, nitric oxide, and nitrogen at the recorded temperature and pressure, the quantities of carbon and nitrogen in the water residue are calculated. From the latter the nitrogen of the free ammonia which has been determined by Nessler's reagent is deducted, less the loss during evaporation, to give the organic nitrogen. Several blank experiments have to be performed by the operator to determine the average error of his method of conducting the operation. In Dr. Frankland's laboratory the blank experiment on one liter of pure distilled water gives .05 mgrm. of nitrogen, equaling .005 part per 100.000 of the water.

Much time, many precautions, careful manipulation, and mature experience are necessary to the successful issue of these gaseous determinations; but these are more or less requisite in all analytical investigations, and should not be viewed as an objection if the desired result is obtained when all is done. If the object of the analysis is to determine the absolute quantities of carbon and nitrogen present in a residue, this process will give the only accurate returns which chemistry at present can furnish. But the problem to be solved is the wholesomeness of a water. Did the organic matter of water residues consist of separable entities so well known that generic and specific differences could be predicated on variations of the total and ratio of these two elements, the time and labor expended in their estimation would be amply repaid. But organic matter is a general term, comprehending substances as harmless as sugar and as noxious as the cholera poison. Variations in the elementary constitution of such a composite do not constitute evidence as to character of sufficient importance to call for scientific accuracy in their determination, if the same evidence can be obtained by simpler or readier methods. There appears to be in fact as little practical value to sanitary science in the methodical elementary analysis of the organic part of the residue as in the formal and scientific analysis of its inorganic salts.

But without discussing the value of this process at the present time, it is sufficient to report that several considerations excluded it from adoption in the sanitary analyses herein recorded. The fragility of the apparatus constituted an objection to its use in a traveling laboratory; and the time consumed by the process was of consequence where much had to be accomplished in a short period, especially as it was believed that as thorough a knowledge of the organic constitution of a water in its sanitary aspect could be attained by other and shorter methods.

During the ignition of an organic residue more or less of blackening takes place, and the intensity of the blackening or the thickness of the carbonaceous film, in other words the quantity of coke in the eschar, enables a rough estimate of the organic matter to be formed. The oxygen of organic substances, although often present in large quantity, is never sufficient for the oxidation of the carbon combined with it.

Carbon always remains behind when heat is applied in the absence of air as in destructive distillations; and when the flame is suddenly applied to the platinum capsule something similar occurs. The oxygen of the contained matter unites with a part of the carbon and escapes as carbonic oxide or acid. Hydrogen is seized and watery vapor is evolved. Nitrogen and hydrogen unite and arise as ammoniacal vapor or as other volatile combinations of a retrogressive character. Carbon particles are carried up by the ascensional force. The oxygen of the air participates in the dissipation of the carbon, but the action has been so instantaneous that the surplus carbon is visible in its elementary condition and requires the continued play of the flame before it is all converted into gas. It is evident that if the oxygen required to dissipate this visible carbon could be measured it would furnish a more discriminating test for its quantity than is afforded by the depth of the color or thickness of the film. The oxygen necessary to the complete combustion of an unknown organic substance cannot be considered as a quantitative test for that substance, nor for any of its elements, as there is always an unknown dissipation produced by the oxygen contained within itself. But it may properly be regarded as a test for the surplus of carbon to which it can give an approximative quantitative expression. The amount of oxygen required to oxidize the oxidizable matters in a water has therefore been tabulated above as a means of affording a view of the organic matter on its carbonaceous side.

There are many substances which contain oxygen and yield it freely under appropriate treatment. They are known as oxidizing agents. Chlorates, nitrates, bichromates are used in various chemical processes. But there is one salt, potassic permanganate, which possesses advantages over all others as an oxidizer in water analysis. Its stability when properly cared for, the beauty and delicacy of its color reaction when properly applied, and its rapid and definite reduction, render it a valuable agent in sanitary analyses. It is not, as is frequently assumed, a test for organic matter, for other substances may affect it.

Permanganate has been used for many years in connection with water investigations, but frequently in such a loose way, both as to method and valuation of results, that much discredit has been thrown upon it.

When a few drops of permanganate solution are added to a water containing dissolved organic matter, the brilliancy of the color speedily disappears and is replaced by a reddish-brown turbidity. Ultimately, if the organic matter is in excess, the water becomes colorless as before, but a sediment which did not previously exist can be seen in the vessel. Part of the organic matter has been destroyed—burned up while in solution in the water as effectually by oxygen from the permanganate in conjunction with its own, as if the process had taken place in a platinum capsule by heat and the oxygen of the atmosphere. The permanganate also has been destroyed, and with it its beautiful color. Part of its oxygen has entered into new combinations with the elements of the organic matter, while the remainder has been precipitated with the metal constituting peroxide in the sediment. The progress in this reaction is slow, but heat accelerates it; and the addition of sulphuric acid not only removes turbidity by combining with the liberated oxide, but increases the activity of the oxidation by freeing more oxygen during the combination—the peroxide is dissolved to a proto-salt. But, even with these adjuvants, the action on organic matter is tedious and the conclusion of the experiment uncertain. Those analysts who make use of the permanganate in this way add a certain quantity of acid to the water with enough permanganate solution to give a definite color. Heat is applied and the temperature raised to 140° Fahr. (60° C.), more permanganate being added if meanwhile the color has disappeared. The test solution is then dropped in from time to time, as required, until a color is produced which does not fade within ten minutes of the last addition. The quantity of the reagent which is necessary to produce a like color in an equal volume of pure water has to be deducted from the result.

As thus used, however, there is a difficulty in pronouncing whether more should be added or whether the experiment should be considered as concluded. The temperament of the analyst has much to do with the quantity of permanganate solution required. Experiments by the same individual may be comparable, as his personal equation will probably not vary much, but not so the results of different experimenters. What is required to make the process of value is an indicator of the termination of the reaction, or of the quantity of test-solution destroyed by the oxidized matters.

There are two substances which decompose permanganate readily, and when in excess leave a perfectly clear and colorless solution under the conditions which are present in a water examination. One is iron in the ferrous state, and the other oxalic acid. The former cannot be utilized on account of its unstable character, but no such objection attaches to the latter, and accordingly it was made use of in the analyses which follow. Kubel first suggested its use in connection with the permanganate in water analyses. An oxalic solution is made of such a strength that 1 c. c. will decolorize the same measure of the colored test. The organic matter of the water is oxidized by an excess of the permanganate aided by heat and acid. Oxalic acid is added so as to remove the color from the water, and permanganate is then dropped in grad-

ually until the color begins to reappear, when the experiment is finished. The permanganate has been destroyed by the organic matter of the water and the oxalic acid, but as the quantity consumed by the latter is known, that for which the organic matter is responsible is easily ascertained. The addition of the oxalic acid with the subsequent subtraction of its known influence has the advantage of yielding the required result while substituting its rapid and definite reaction with the colored test for the uncertainty attending the action on the organic matter.

Instead of oxalic acid to determine the excess of the last solution remaining after the oxidation of the organic matter, Dr. Tidy makes use of iodine. Briefly, his process is as follows: A quantity of the water to be examined is treated with sulphuric acid and permanganate in excess of that required to oxidize the impurity so that at the end of three hours, when the action is finished, there shall still be color visible. The decomposition is permitted to take place without heat. Potassic iodide is then added to destroy the residual permanganate. In its destruction it liberates an equivalent quantity of iodine, which, having been estimated by sodium hyposulphite with the blue iodide of starch as an indicator, becomes a measure of the excess of permanganate, and enables the operator to arrive at the quantity of that salt which has been destroyed by the water impurity. But as the hyposulphite is very unstable, a standardizing experiment has to be performed along with each analysis.

The method by oxalic acid is preferable as being simpler and more rapid than the other, and equally accurate. Its solutions are not liable to spoil like that of the hyposulphite. Enough may be prepared at one time for a long series of analyses, and the blank experiment requires only to be performed when the solutions are renewed.

The following are the practical details of the process. A solution of permanganate is to be prepared which shall contain about .1 mgrm. of available oxygen in each cubic centimeter. One molecule of potassic permanganate gives up 5 atoms of oxygen to oxidizable matters, in the acidulated water; 80 parts by weight of oxygen are therefore yielded by 316 parts of the salt, or one tenth mgrm. of oxygen by .395 mgrm. This is the quantity which should be present in each cubic centimeter of the test solution. Were the salt always chemically pure it would suffice to dissolve .3950 grm. in a liter of distilled water, but as it is not reliable in this respect, it is better to dissolve .4 grm. in the liter and find the exact strength of the solution by means of ferrous sulphate.

To this end a few pieces of slender iron wire, free from rust, are accurately weighed and dropped into a small flask containing about 25 or 30 c. c. of diluted sulphuric acid. A tightly-fitting perforated cork must be used with a small piece of glass tubing inserted into the perforation so that it projects a very little above the top of the cork. A piece of thin rubber band is pinned to the cork, bridging over and obcluding the end of the tube. The band thus serves as a valve which permits of the escape of steam and hydrogen gas from the interior of the flask, but prevents the ingress of air which would act upon the iron and impair the valve of the experimental result. The exclusion of atmospheric oxygen may also be accomplished by fitting the perforation in the cork with a glass tube surmounted by an inch or two of rubber tubing closed at its upper end by a bit of glass rod. A longitudinal slit in the rubber tube serves to admit of escape and deny entrance.

The flask is heated by placing it in a vessel of warm water, and in the course of an hour a solution of ferrous sulphate is obtained which contains the weighed quantity of iron. A second flask is prepared in like manner, and in case of accident it is well to have a third with its known charge of iron convenient.

As soon as the iron is dissolved, the cork is removed and the permanganate solution is run in from the burette and then dropped more cautiously until the last drop pervades the liquid with a tinge of color. The quantity used to ozidize the iron in the flask is noted, and the experiment is repeated on the contents of the second flask.

Two atoms of iron in the condition of ferrous salt require but one atom of oxygen to convert them into ferric sulphate, *i. e.*, 112 parts by weight of iron are converted by 16 of oxygen, or, in simpler figures, 7 parts by 1. We have thus the necessary data for obtaining the true oxygen strength of the permanganate solution. The iron present is divided by the number of cubic centimeters decolorized, and the value in iron of 1 c. c. obtained, which, when divided by 7, gives the amount of available oxygen in each cubic centimeter of the solution. But as the iron has usually an impurity of three or four tenths of a per cent., it is customary to make a correction on its account.

In one flask 21 mgrms. of iron (99.6 pure) required 30.6 c. c. of the permanganate solution; while 48 mgrms. in a second flask decolorized 70 c. c.

$$21 \times .996 = 20.916 \text{ mgrms., the corrected iron weight.}$$

$$\frac{20.916}{30.6 \times 7} = .0976 \text{ mgrms., the oxygen yielded by 1 c. c.}$$

$$48 \times .996 = 47.808\text{, the corrected iron weight.}$$

$$\frac{47.808}{70 \times 7} = .0976\text{, the oxygen yielded by 1 c. c.}$$

In this case the results of the two experiments correspond so exactly that their testimony may be accepted as final, and the strength of the solution marked upon the label 1 c. c. = .0976 mgrm. oxygen. In the event of a discrepancy the third flask should be carefully tested. Although .4 grm. per liter are sufficient to give a theoretical strength of over .1 mgrm. of oxygen in every cubic centimeter, the impurity of the salt is such that this strength is seldom obtained. By dissolving a few centigrams more than this quantity the solution could be subsequently diluted to .1 mgrm. per cubic centimeter; but this involves unnecessary trouble. While it is essential to know the exact strength of the solution, it is simply convenient, in view of the purpose for which it is to be used, to have it about the strength indicated.

The burette employed in the permanganate experiments should contain 25 or 30 c. c. and be graduated to tenths. Delivery must be effected by a ground glass stop-cock, as rubber decomposes the reagent.

The oxalic solution should be made to approximate in strength to that of the permanganate, but it is not needful that they be accurately equivalent. One molecule of oxalic acid is destroyed by one atom of oxygen. Sixteen parts by weight of the latter are thus equal to the oxidation of 126 parts of the crystallized acid, or .1 mgrm. to .787 mgrm. Each cubic centimeter of the solution should therefore contain about this quantity of acid. By dissolving .790 grm. of ordinarily pure acid in a liter of distilled water, a solution will be obtained which will answer the purpose. A burette with a rubber tube and clip should be mounted on a stand along with the permanganate burette and be reserved for the oxalic solution. A 10 c. c. pipette would serve equally well, but where many examinations are probable it is better to have the burettes mounted together and made use of for no other reagents.

The sulphuric acid should be diluted with three or four parts of water, and stored in a capped bottle, which will permit the 10 c. c. pipette used in delivering it to be included in the bottle when not in use.

The only other requisite is a water which approaches as nearly as possible to the state of absolute purity. As the ordinary distilled water may not be sufficiently pure it should be redistilled from a glass retort, which should have no rubber connections; and that nothing which can act upon permanganate may remain in it, a little of that salt dissolved in a solution of caustic potash should be added to the water in the retort. As soon as the distillate is found to be free from ammonia it is to be collected for use.

To determine the relation which the oxalic bears to the permanganate solution together with the influence on the latter of the treatment to which it is subjected during the experiment, 200 c. c. of the redistilled water are put into a 350 or 400 c. c. flask. A charge of diluted sulphuric acid is added from the 10 c. c. pipette, and 10 c. c. of the permanganate solution is run in from the burette. The flask is then placed over a gas flame, heated to boiling, and kept boiling briskly for ten minutes, during which time it loses neither color nor lustre. A thick paper guard is passed around its neck to protect the fingers, and it is removed to the burette stand, where 10 c. c. of the oxalic solution are delivered into it. Effervescence occurs from the escape of carbonic acid resulting from the decomposition of the oxalic, and the liquid in the flask becomes colorless. Permanganate solution is then cautiously dropped in while a swirling motion is given to the contents. Each drop has its color destroyed as it is swept round by the motion of the liquid, but ultimately a drop falls which does not color the water so much as it changes its complexion, while that which follows gives a definite color. The termination of this reaction is very distinct when closely watched under favorable circumstances. The light should be thrown by a white reflector—a sheet of paper at a proper angle—through the liquid to the eye. The change in the lustre prepares the operator to turn the stop-cock, as the next drop will assuredly suffice to give a tinge of color.

The quantity of permanganate added to the flask is not the amount used in destroying the oxalic acid. It is the amount destroyed by whatever decomposing influences are presented by the experiment as performed on a water which is known to exercise none. The oxalic acid constitutes the principal of these influences, but impurities in the sulphuric acid and organic matter from the air during the exposure are included, together with the effects of the boiling, and the quantity necessary to change the complexion of the liquid and colorize it. Therefore, though we may for convenience label the oxalic solution with the result of the experiment thus: 10 c. c. oxalic = 10.9 c. c. permanganate, it must be remembered that all decolorizing causes are covered by the expenditure of 10.9 c. c.; so that when the experiment is repeated on an impure water, all the conditions other than the impurity in the water remaining as before, any increase in the expenditure of permanganate must be due to the intruded influence of the impurity.

The necessity for absolute purity in the water used in the above experiment can now be appreciated. Were it impure the results of subsequent experiments on other waters would only express their relation to its unknown quality as a standard; but

with it absolutely free from organic matter or other substances which act on permanganate, the results become endued with an absolute instead of a relative value.

Thus, the examination of a given water by this process is seen to consist of a repetition upon it of the experiment just described with a deduction from the permanganate used of that quantity (10.9 c. c. in the example) destroyed by influences other than the impurity in the water. The number of cubic centimeters credited to the water impurity are then multiplied into their value in oxygen, and as 200 c. c. were used in the experiment, the product is divided by 2 to express the oxygen in parts per 100,000 of the water.

For example, using the figures already given, the 200 c. c. of the sample treated with acid and permanganate are heated, and boiled for ten minutes, during which time the liquid, instead of retaining its color and luster, fades considerably, but still preserves a definite color. Had the red disappeared entirely, leaving in its place a pale straw color, it would have been necessary to have added more permanganate, making note of the quantity added. This, however, is seldom required. The flask is removed, the oxalic solution is introduced, and in a few seconds, when the color is entirely destroyed, the permanganate is delivered *guttatim*, at first pretty rapidly, as we know by the fading that a large proportion of the original 10 c. c. has been decomposed, but afterwards cautiously, giving time to note after the fall of each drop the effect which it produces on the whirling liquid. As soon as the change and the coloration appear, the dropping is checked and the quantity ascertained. Subsequent to the employment of the oxalic solution 6.9 c. c. have been used, which, added to the original 10 c. c., give 16.9 c. c. as the total.

16.9	total permanganate used by 200 c. c. of sample.
10.9	deducted for oxalic, &c.
6.0	permanganate used by water impurity.
.0976	oxygen value of 1 c. c.
2).5856	
.2928	oxygen in parts per 100,000.

Two hundred cubic centimeters are employed in the experiments as the organic matter in this quantity of ordinarily pure drinking water requires from 1 to 3 c. c. of the permanganate solution for its oxidation; and 3 c. c., each divided into tenths, afford ample room for discriminating differences of quality, while of course with impure waters the measure of permanganate required is increased. Were all waters notably impure, 100 c. c. would be enough for the experiment, but they hardly suffice for the grading of good waters.

The test as thus employed occupies little time, is sharp in definition, and constant in its results on portions of the same sample. The information which it conveys remains to be considered.

The quantity of permanganate used by a given water must be recorded as that required for the oxidation of all oxidizable matters which are present. Potable waters frequently contain substances which decompose permanganate, and which, though related to organic matters, must not be estimated with them. Nitrous acid and hydrogen sulphide are often met, the former in variable quantity, the latter in traces only. Iron can be detected in all waters which have penetrated the soil, but the quantity is usually so minute as to have no practical bearing on the issue of the permanganate experiment. By boiling the water sample with the diluted sulphuric acid for twenty minutes these permanganate decomposers are destroyed. Iron is oxidized, hydrogen sulphide is dissipated, and the nitrites are converted into nitrates. Dr. De Chaumont has shown that this conversion of the nitrites can be effected without loss to the organic substances. This matter will be referred to again in speaking of the estimation of nitrous acid.

If nitrites are present the 200 c. c. of the water sample must be boiled for twenty minutes with the sulphuric acid, loss by evaporation being replaced by pure water. This is followed by treatment with permanganate, oxalic acid, and permanganate again, as above described, for the oxygen required to oxidize the organic matter.

But while deoxidizers other than organic matter which may be present in a water are thus easily disposed of, the process has a reverse side which cannot be dealt with in so satisfactory a manner. The co-operation of heat, acid, and permanganate determines the decomposition of organic substances, but the resulting combinations are as unknown as the original material. On this account no estimate can be formed of the quantity of the organic matter from the amount of oxygen taken up by it. But further, some organic substances are unaffected by the permanganate—urea, for instance—so that the purity of a water cannot be deduced from the result. Most of the wells in Brownsville, Tenn., which were found largely contaminated with sewage, would have

been pronounced by this test as singularly free from organic impurity. So also the shallow wells of Mobile, Ala. Nor can unwholesomeness be established by its testimony alone, as the innocuous particles of carbon which are swept from the roof into a cistern produce, atom for atom, a greater effect upon the colored solution than if they were the combined carbon of a subtile organic poison.

For these reasons, rules assigning character to a water in accordance with the results yielded by this test must be accepted with caution. Good and usable waters, according to the usual statement, should not require more than .15 part of oxygen, but there are undoubtedly bad waters which do not approach this limit. Six of the Brownsville waters required less than .05 part.

Water is regarded as doubtful when more than .15 part is necessary, and as unfit for use when the oxygen exceeds .2 part. This is a safer rule than the first, but it is true only in general terms of well and spring waters where the contamination is caused by animal waste. Where the impurity is of a vegetable character the limit must be somewhat enlarged, else many good cistern waters would have to be condemned. For instance, those of the Linden-street public schools, Memphis (analyses 70 and 71), which require, the one .3264, and the other .2266 part. The oxygen required for cistern waters varies according to the character of the roof. Shingles are prone to accumulate sooty depositions, which raise the oxygen figure without adding a corresponding danger. In their decay vegetable matters may be given up to the water shed from them, which will render it proportionately impure, but by no means so dangerous in its impurity as a well water contaminated by animal matter requiring the same quantity of oxygen. A cistern water may thus contain, without prejudice to its character, a quantity of carbon which would suffice to condemn a well water.

It is only when the permanganate result is considered in connection with other testimony that its value can be estimated. The Frankland and Armstrong combustion experiment determines the organic carbon and the organic nitrogen, and from their relative proportions esteems the original matter as of animal or vegetable deriviation, and accordingly as of more or less serious import. The permanganate process may be viewed as a simple and practical method by which an approximation to the carbon may be obtained. No claim for accuracy in the determination of the carbon can be advanced, any more than in the case of the organic matter, since the action which is exerted on the various carbonaceous compounds is unknown. The result accurately stated is the quantity of oxygen required by those elements of the organic matter which have been left unaffected by the redistribution of the organic oxygen under the conditions of the experiment.

Experience, however, in the treatment of water residues gives warrant for the assertion that the quantity of oxygen required to oxidize the organic matter is always proportioned to the amount of blackening which occurs on its ignition. In the analyses which are hereafter recorded, this fact was so patent that no effort was made to express it on the record. The exception, however, was looked for and would have been noted had it occurred. Marked carbonization on ignition with a coincident want of action on the permanganate would have constituted an important observation in water analysis as indicating a fallacy in the use of the test solution, the conditions of which would have demanded closer investigation.

To illustrate the action of the permanganate when used as in this analytical method, a stronger solution was made, one containing 1 milligram of available ogygen in each cubic centimeter. Ten milligrams of cane sugar, treated by boiling for ten minutes with the sulphuric acid and permanganate in excess, decolorizing by oxalic acid and again coloring with the test solution, required 8.755 milligrams of oxygen. Ten milligrams treated in like manner, but with the boiling continued for thirty minutes, used 8.858 milligrams oxygen in their destruction. The same quantity of starch treated for ten minutes required 8.549 milligrams. Dried albumen and gluten dissolved in an alkaline solution were acted on less rapidly. Ten milligrams of the former used 3.708 milligrams oxygen in ten minutes, 4.738 in twenty minutes, and 6.798 in one hour. Ten milligrams of gluten used 5.150 miligrams oxygen in ten minutes and 8.446 in one hour. The organic matter in infusions of sawdust and of fresh leaves was entirely destroyed in ten minutes. Ten milligrams of urea boiled for ten minutes with the reagents used no oxygen; and inasmuch as urea is broken up into ammonia by boiling, this experiment shows that the free ammonia sometimes present in water does not influence the permanganate. To test this point, however, 200 c. c. of an organically pure water was ammoniated with .32 milligram of chloride, and then treated for organic matter by permanganate and oxalic acid. The result was negative.

Varying quantities of oxygen by permanganate may thus be regarded as differentiating between shades of blackening by giving expression in figures to its relative amount, or to the relative amount of the carbon by which it is caused. Figures of absolute weight are not a requisite in water analysis. If a water contains carbonaceous matter in sufficient quantity to decolorize the equivalent of .4 part of oxygen, it is immaterial what that carbon weighs when isolated, so long as experience suggests a doubt as to the wholesomeness of a water which contains such a quantity.

Having thus obtained a result which, for the purposes of sanitary analysis is expressive of the carbon, all sources of carbonaceous impurity, as suggested by the known history of the water, have to be considered before a correct hygienic value can be attached to the permanganate decolorization.

The practical teachings of experience are these: Where the water requires more than .4 part of oxygen for its organic matter, it may be considered bad, no matter what the derivation of the substances. No water has been met with containing this quantity which could not be condemned on other grounds.

Where the result varies from .15 to .4 part, the water is suspicious, and further examination will no doubt confirm the suspicion. The evidence on which such a water is guaranteed as wholesome should be very clear.

A sample which requires less than .15 part is a wholesome water, provided the organic matter consists chiefly of the non-nitrogenized products of vegetable life. If the nitrogen which accompanies it is small in quantity, this origin is probable, and the water may be considered free from deleterious organic matter. But if the nitrogen coexists in larger quantity, the favorable opinion given by the permanganate is deprived of value, as there is probably contamination by animal matter.

SECTION V.

ON THE FREE AMMONIA.

The next process in the tabulated method of analysis is one by which a view of the nitrogen of the organic matter is obtained. But as this element is best liberated and estimated in conjunction with hydrogen as ammonia, it is necessary, as a preliminary to the experiment, that all ammonia which may exist in the water be removed from it. The inorganic, free, or pre-existing ammonia can be conveniently estimated during the process of removal. The method by which its separation and determination are accomplished will, therefore, be detailed in this place. It forms, in fact, an integral part of Wanklyn's process for the sanitary analysis of water, which consists of this estimation of the free ammonia and a subsequent determination of the quantity of ammonia which can be evolved by a given treatment from the nitrogen of organic substances.

Ammonia is present in all rain and surface waters, but is usually absent from deep wells and springs, which are uncontaminated by surface impurities. That which occurs in the rain is derived from the atmosphere, where, in combination with nitrous acid, it is known to be formed by the union of elementary atmospheric nitrogen by electric discharge in the presence of moisture. The destruction of watery vapor and organic matters by electric agency are probable sources of atmospheric ammonia. Exhalation from the soil cannot add much to the quantity, as ammonia is found in rain clouds which come from seaward in as large proportion as in landward storms. Indeed the soil, with its growing vegetation, appears rather to be the immediate destination of the precipitated ammonia. Rain water which is collected from a roof may contain more, on account of the products of combustion which are deposited by neighboring flues on the shedding surface, but the rain water which falls over cities brings down no larger proportion of dissolved ammonia than that which is precipitated on unoccupied territories. It would seem, therefore, that the ammonia is generated in the atmosphere itself—that the reduction to inorganic forms which takes place in devitalized organic matter on the earth's surface is also taking place in those particles of an organic nature which we know to be diffused in the air.

The waters of running streams, of ponds, lakes, and other surface collections, contain ammonia contributed by the rainfall, but they may derive additions from contact with decomposing nitrogenous matters in the soil over which they have coursed. Urea, the essential of sewage, is readily broken up into ammoniacal salts.

The yield from the water of shallow wells is proportioned to the inefficiency of the filtration to which the water has been subjected in its progress to the reservoir. It may be derived from the primary fall, or from the subsequent surface additions.

The filtration in the case of deep wells—and by deep wells are understood those in which an impervious clay layer separates the ground water from that of the well—is usually so perfect that ammonia can only be derived by direct inflow from the overlying ground water. Occasionally, in deep wells, ammonia is found in comparatively large quantity without a corresponding amount of undecomposed organic matter to sustain the suspicion of direct surface inflow. It has been suggested by De Chaumont that the ammonia in these cases may arise from a deficiency in the fermentative elements in the soil proper for conducting the oxidation of the ammonia to its ultimate point; namely, nitric acid.

When a sample of water containing ammonia is distilled, the volatility of the latter carries it over with the first portions of the distillate; so that, generally speaking, when one-third of the contents of the retort has passed over the remainder is free from this substance. The test for its presence in the distillate is what is known as Nessler's reagent, a solution of mercuric iodide in caustic potash. This, when added to a watery

solution of ammonia produces a red-brown precipitate; but when the ammonia is present only in minute quantities, a coloration is caused varying from the slightest recognizable alteration in tint to a deep sherry-brown color. The test is so delicate, that with but .0025 mgrm. of ammonia in 50 c. c. of water the color cannot be mistaken.

As an increase in the quantity of ammonia gives a proportionate increase in the depth of color, it is evident that the shade can be made a measure of the ammonia present, the Nessler reagent thus becoming as accurate in its quantitative estimation as it is delicate qualitatively. A glass containing an unknown quantity of ammonia, which has been colored by Nessler's solution, is matched in depth of tint with another containing a known quantity, and as the depth of tint is proportioned to the ammonia present and to nothing else, the unknown becomes known. There are certain substances frequently present in potable waters which interfere with the coloration by causing turbidity, but as the ammonia in the analysis is separated from these by the distillation, it is needless to refer to them specially.

Nessler's solution is prepared, and kept for use in a tall bottle having a capacity of fully 200 c. c. It should be glass-stoppered and capped. When the solution is being used, the cap inverted on the table forms a convenient place of deposit for the 2 c. c. delivery pipette during the intervals of its use. Measure out 200 c. c. of distilled water; put about 20 c. c. of the water into the Nessler bottle with 7 grms. of potassium iodide; pour about 60 c. c. into a small beaker containing 3.2 grms. of mercuric chloride, and dissolve with the aid of heat; dissolve 32 grms. of caustic potash (or 24 of caustic soda, the alkalinity or saturating power of which is relatively greater) in the remainder of the water; add the mercuric solution to the iodide in the bottle little by little, shaking gently after each addition to promote the disappearance of the precipitated flakes; proceed in this way until a drop has been added in excess, giving a permanent scarlet tinge to the liquid; now pour in the solution of caustic alkali; the red tinge disappears, and is replaced by a faint yellow color; add a drop of the mercuric solution, this causes a grayish scum; shake the bottle well, stopper and cap it, and set it aside; in a few hours it will be clear and ready for use. It is needless to decant it from the slight sediment, as the pipette can be used on the solution without disturbing it even when there is but little liquid in the bottle. Where many ammonia estimations are probable, a larger quantity of the Nessler solution may be prepared, and the clear liquid from the stock-bottle poured into the smaller one for use.

In order to match the color produced by this reagent in an ammoniated water, a standard solution of ammonia is required, and a distilled water which is free from ammonia. The standard used contains .01 mgrm. in each cubic centimeter. Ammonic chloride which is employed in making the solution has 17 parts of ammonia by weight in 53.46 parts, or .01 mgrm. in .0315 mgrm. The standard is therefore made by disolving .0315 grm. in one liter of water. A 10 c. c. pipette graduated to tenths is used in its delivery.

The distilled water may be considered free from ammonia if 50 c. c. give no color when treated with 2 c. c. of the Nessler solution. Such a water is not absolutely free from this omnipresent gas, for concentration by distillation may develop its presence, but it is pure enough for the purpose. If the ordinary stock of distilled water does not, as is probably the case, respond satisfactorily to the test, it must be boiled until all ammonia is driven off.

The apparatus required for the experiment consists of a measuring flask, a retort and stand, a Bunsen burner, and rubber tubing to connect with the gas jet, a Liebig's condenser with a convenient water supply, and a series of test glasses in which to receive and test the distillates.

The flask should have a capacity of 500 c. c. and it should be used only as a water measure.

A retort capable of holding more than a liter (32 oz., for instance) should be selected, for although only 500 c. c. are used in the experiment, spirting is apt to occur during the distillation, and if the surface of the liquid is not considerably below the angle of the retort undistilled water may be carried over and cause a turbid interference with the subsequent color-tests. Any imperfection in the glass, such as air-flaws or inequalities should cause its rejection. The stopper should be accurately ground and the tubulure be well over the body of the retort, so that when in position a funnel can sit upright in it for the introduction of liquids. The stand should have a heavy base and be furnished with a strong clamp which admits of the adjustment of the retort both as to height and incline. In addition to the ordinary downward incline of its tube, the retort when in position should be slightly rotated between the cork-lined jaws of the clamp so as to make the tubulure deviate a little from the perpendicular. This will avoid fracture of the apparatus by the stopper if it should be thrown out by a sudden steam-burst. The slight rotation carries the stopper clear of the retort in its fall. With waters which bump a good deal during their treatment this is a very necessary precaution.

The retort tube should be drawn out to fit the tube of the condenser. There is no objection to a rubber connection, provided water can be distilled through it which gives no color nor turbidity with the Nessler solution. The condensing tube must be in line

with the long axis of the retort, and its distal end be curved for delivery into the test glasses. It is convenient to have the condenser connected with the tap, as after the flow is once regulated no further attention is necessary, but if a running stream is not available, a large pail or reservoir may be placed above the level of the condenser and its contents be siphoned through the apparatus. A little experience will indicate the rapidity of flow needful to preserve the condenser in proper condition without waste of cold water, and the delivery tube of the siphon may be drawn to a small orifice and a pinch-cock used on a rubber portion of the tubing to obclude part of its caliber.

The test glasses, or Nessler glasses as they are called, are cylinders about 18 c. m. (7 inches) in height, and 2.3 c. m. (.9 inch) in diameter. They contain nearly 70 c. c., and have a mark at the 50 c. c. level. They should be of clear and colorless glass, and without foot-pieces. Small sockets of turned wood are convenient holders for them when not in actual colorimetric use.

Everything being in readiness, and the measuring-flask, retort, test glasses, &c., known to be perfectly clean, 500 c. c. of the sample are poured directly from the flask into the retort, which is held in the hand, so that the water runs down along that part of the wall farthest from the exit tube; a funnel is unnecessary. The retort is then stoppered and slid into position between the jaws of the clamp, rotated slightly, and the end of its delivery tube connected with the condenser, when a slight turn of the screw tightens the jaws and secures the apparatus in position. A large bunsen flame is applied to the bottom of the retort—if a spirit lamp is used the wick should be pulled well out and flattened, to give a large, broad-based flame. The flame, however, should not lap the walls of the retort above the level of the water. A Nessler glass is placed to receive the distillate, and the circulation in the condenser is started; but if economy in cold water is an object, this need not be done until the contents of the retort begin to boil.

Sodium carbonate is added to the water by some operators, to promote the volatilization of the ammonia, but its presence is seldom necessary. In the analyses which follow, its assistance was needful only in two cases: a cistern water in New Orleans (Analysis 35), near the ammonia-works and largely impregnated by them, and another in Memphis (Analysis 140) containing much urea. Professor Wanklyn does not employ it under ordinary circumstances.

As soon as the first Nessler glass is filled to the mark it is replaced by a second, this by a third, and so on until 50 c. c. are obtained which give no indication of the presence of ammonia. In dealing with pure waters all the ammonia is removed in the first glassful, but a second is distilled to make sure of the removal. Ordinarily three distillates are required, less frequently four, and in rare cases five. Two distillates are always necessary; and, as a water which contains a large quantity of ammonia may so charge the first Nessler glass as to produce a turbidity which would prevent accurate estimation, it is better to begin the quantitative estimation on the second glass. As soon as this glass is removed, 2 c. c. of Nessler's solution are added to it by the pipette. In the course of two or three minutes the color has developed, and it remains to match it with a solution of known strength. Where much work of this kind has to be performed, it is convenient to have on the table four glasses, freshly prepared every day, containing, respectively, .01, .03, .05, and .07 mgrm. of ammonia, equaling 1, 3, 5, and 7 c. c. of the standard solution made up to 50 c. c. with distilled water, and colored by the addition of the test solution. As soon as the tint has developed in the second distillate, it is seen at a glance whether it corresponds with any one of these known mixtures, whether its shade places it between two of them, or whether it is lighter or darker than the extremes of the series.

If it corresponds with .03, for example, to further test the accuracy of the correspondence a fresh glass of that strength may be prepared.

If it takes rank between .03 and .05, the eye can readily discriminate to which side of the central point it tends, whether it corresponds with an imaginary .04 or is lighter than it or darker than it, and a sample glass can be prepared containing .035, .04, or .045 as may seem required.

If it is lighter than the .01 at the one end of the series, a glass with .005 or ½ c. c. of the standard will enable the eye to define the quantity which it contains. If it is darker than the .07 at the other extreme, the color of .08, .09, or .10 may be tried, but if darker than the last it is better to pour away one-half or one-fourth of the liquid, replacing it with distilled water, and match the tint of this diluted solution for one-half or one-fourth as may be of the ammonia originally distilled into the glass.

The matching is best accomplished by looking down through the columns of liquid contained in the glasses to a sheet of white paper placed at such an angle as will reflect the light from the window directly upwards. The glasses should not stand upon the white surface. Better light and definition are obtained by holding them in the hand over the inclined paper.

This estimation of the ammonia in the second glass enables the operator to deal satisfactorily with that in the first. Should the second contain less than .05 milligram the Nessler test may be added to the first and the color produced be compared as al-

ready described. Should it contain more than .05 milligram, one-half, one-fourth, one-tenth, &c., as may seem advisable, may be taken from the first, diluted to 50 c. c. with distilled water, and comparison instituted as above for the quantity of ammonia. A third, fourth, or even fifth glassful is distilled and compared with the standards until the last glass gives no reaction with the Nessler test; but if the second glass shows no color, the experiment is satisfactorily terminated at that stage, as the ammonia originally present in the retort has been separated and estimated, and the water now remaining in it is ready for the generation and evolution of that to be formed from the nitrogen of its organic matter.

It is Professor Wanklyn's practice to estimate the ammonia in the first 50 c. c., then to distill over 150 c. c., which are thrown away without examination, as his experience has shown that by adding one-third to the amount found in the first glass the total of ammonia is obtained. By this means the trouble of Nesslerizing is lessened. But it frequently happens that there is no need for prolonging the distillation after the examination of the second glass, and it is doubtful if the addition of one-third will accurately represent the total in cases where there is a large quantity of ammonia present, although the rule holds good in the generality of waters. Besides, the estimation of the second enables the first to be treated so as to avoid turbidity if the ammonia is large. For these reasons the method recommended above is considered preferable.

As Nessler's reagent becomes turbid with ammoniacal solutions other than the most dilute, it should never have the standard ammonia added to it in making up sample glasses. The reagent should invariably be the last addition to the test glass. For the same reason these glasses must be thoroughly rinsed out after use and preparatory to a fresh experiment.

A casual inspection of the water in the retort during the distillation gives information concerning the quantity of lime carbonate present in the sample. Water which remains clear throughout the experiment cannot contain more than three parts of this salt. The degree of removable hardness is proportioned to the turbidity produced by the boiling.

With a little practice the estimation of ammonia by the color test can be effected with precision in very little time. It has been objected that it is an impossibility to obtain accuracy in this way, because, first, the shades produced by differing quantities vary so little; secondly, because the shade caused by a given quantity is not of fixed depth, but goes on deepening as time passes; and, thirdly, because color shades are so difficult of discrimination, no two people deciding alike, on account of variations in the acuteness of the color sense. Such objections come from those who have manifestly no practical knowledge of the matter. The tint produced by .03 milligram, for instance, is not only lighter than that caused by .04 milligram, but it is so much lighter that fractional parts of the .01 milligram of difference between them can be appreciated. The color requires a few minutes to attain its full development. This is granted; and the time is allowed before the comparisons are made. For several hours after this no appreciable change takes place. After an exposure of a day or two in the Nessler glass a slight precipitate or a pulverulent film on the surface indicates unreliability, but fresh glasses for comparison are easily prepared. So far as the color perception of individuals is concerned, a large experience has discovered no one, with intelligence enough to understand what has to be done, who could not pronounce upon the tints as well as a practiced operator. Color-blindness may be common in its minor degrees, but it is not color perception which is required in this case. It is a recognition of the depth of shade in identical colors—with which color perception has nothing to do. Even the color-blind possess the ability to distinguish such differences.

The estimations are entered on the record, and as 500 c. c. of the sample were employed, their sum is divided by 5 to express the ammonia present in parts per 100,000. Thus, rain which fell in New Orleans March 12, 1880, gave:

Free ammonia—1st,	.18
2d,	.06
3d,	.02
4th,	.005
	5).265
	.053 parts.

The quantity of ammonia in rain varies considerably—from .10 to .70 parts. The first result has been frequently obtained, for instance, at Fort Preble, Me., June 17, 1879, after twenty-four hours of a heavy fall. Usually the first part of a rainfall is more highly charged than the latter part, but this is not always the case. The New Orleans rains instanced above gave the stated result in the average water of the first three hours of the fall, but .071 part was obtained from that of the subsequent hours, a good deal of electrical disturbance accompanying the precipitation. These

figures were given by the water as collected in clean dishes. If shed from a roof or other surface the quantity would no doubt be increased. Water from the roof of a hotel in Memphis gave .076 part.

Since the ammonia in rain-water as it falls from the clouds is so variable, it might be expected that its quantity in stored waters would have no significance. But this does not follow; for conditions which affect the water during its storage tend to reduce its ammoniacal figure. It is probable that ammonia is removed by microscopic vegetation which thereafter settles and adheres to the bottom and sides of the cistern. At all events it is certain that rain-water containing .030, .040, or more parts may enter an underground cistern in large quantity and yet the water of that cistern be found two or three days afterward to yield only .001 part or less. An examination of the cistern water analyses hereafter given will show that such waters may contain no ammonia, and that the probability of organic impurity increases with the ammonia figure. On the other hand, when the water is stored in wooden tanks the dissipation is not so thoroughly effected. The waters of New Orleans yielded .003 and .005 part, but more frequently .010, or rather more, as corresponding with their best specimens, while any marked increase was usually an accompaniment of organic impurity in the absence of a recent rainfall to account for its presence.

Ammonia in river waters has no sanitary value, as it depends on the rainfall. Thus Wolf River water, when influenced by rains on November 18, 1879, gave .022 part, while on December 2, no rain having fallen for four or five days, the amount found was only .001 part.

Well and spring waters should contain but a trace, certainly not over .002 part. But the absence of ammonia, though mostly coinciding with organic purity, cannot be accepted as a proof without corroborative evidence. In the wells 371 Vance street and 116 Front street, Memphis (Analyses 225 and 228), the water, although very impure, yielded less than .001 part. Where the ammonia is over .002 part there is generally some contamination, the origin of which must be ascertained.

SECTION VI.

ON THE ORGANIC AMMONIA.

The water in the retort having been pronounced free from ammonia, the stopper and gas flame are immediately removed and the reagents introduced, which are intended to break up the organic matter and liberate its nitrogen in the form of ammonia. These consist of potassic permanganate and caustic potash. In the decolorization experiments sulphuric acid is used as an adjunct, because it increases the efficiency of the permanganate and clears the solution for the observance of the amount of color destroyed. In the present case, however, the quantity of permanganate decomposed is of no consequence, provided a sufficiency is present to effect the destruction of the organic matter. The evolved nitrogen is the objective point in the experiment; and to increase the efficiency of the permanganate and aid in the expulsion of the newly-formed ammonia the fixed alkali is employed.

The ammonia which is thus generated is known as the organic or albuminoid ammonia, in contradistinction to the free, saline, or inorganic ammonia which has been removed by the simple distillation. Albumen, a nitrogenous organic substance, yields ammonia under this treatment. Other organic matters which are similar to it in elementary composition, such as fibrin, casein, legumin, &c, also yield ammonia. These are albuminoids.

It is imperative, of course, that the reagents to be used in the experiment should be absolutely free from any contaminating ammonia. The directions given for the preparation of the alkaline permanganate solution are intended to ensure this purity. Of the distilled water, such as is used in making up Nessler samples, boil about 900 c. c. in a glass flask until it has lost 150 c. c. Dissolve 100 grms. of caustic potash and 4 grms. permanganate in 600 c. c. of the boiled water, and continue the ebullition in a porcelain dish until 150 c. c. have been dissipated. Make the solution up to 500 c. c. with boiled water and preserve for use in a glass-stoppered bottle.

A small glass funnel and a 50 c. c. measure are set apart for the measurement and introduction of this solution. The charge of 50 c. c. required for each water contains .4 grm. of permanganate and 10 grms. caustic potash. It is advisable, after having added this charge to the contents of the retort, to spirt a little distilled water over the funnel in order to carry away the deeply colored drop which adheres to its lower end, as in the removal of the funnel it might touch the mouth of the retort and taint the subsequent distillate. The stopper is then inserted into the retort, the flame reapplied, and the distillation continued as before.

The second distillate of 50 c. c. is examined as in the case of the free ammonia. If it contains none, the experiment is at an end and the ammonia in the first glass is estimated. If it contains much, the first glass is diluted for estimation, and the distillation is continued until a glassful is obtained which gives no reaction with the

Nessler test. Two distillates suffice in dealing with pure waters; three are generally required, and occasionally four.

During the distillation from the alkaline permanganate the operator is sometimes annoyed by the violent bumping of the liquid. In seven of the samples hereafter recorded the note-book shows this to have been worthy of special mention. But even when it occurs there is usually no difficulty in collecting the first and second distillates. It is only as the solution becomes concentrated that danger of breakage threatens. The stopper may be thrown suddenly from the retort, and on this account the rotation already suggested should be given to the apparatus. Keeping the liquid in motion appears to promote a more equable evolution of the vapor. The cause of the bumping is obscure. In three of the seven cases the waters were highly charged with vegetable impurity, while four were stored rain-waters which were by no means impure.

The results of the experiment are recorded as follows:

Albuminoid ammonia	1st,	.10
	2d,	.04
	3d,	.01
	4th,	.00
	5)	.15
		.030 parts.

The figures here given are those of the New Orleans rain, which was used by way of illustration in the case of the free ammonia.

The carbon of organic matter cannot be calculated from the permanganate decolorizations, nor can its nitrogen be estimated from the yield of albuminoid ammonia; but the result has a certain relative value in the one case as in the other. The decomposition which takes place in albumen under the conditions of the experiment is unvarying, and the quantity of ammonia is proportioned to that of the destroyed matter. The whole of the nitrogen of the albumen is not recovered as ammonia, but the percentage is the same whether in dealing with stronger or weaker solutions. It may be that the caustic potash determines the combination of a portion of the released nitrogen with oxygen to nitric acid. The residue in the retort has not been examined for the missing nitrogen.

It is probable that the nitrogenous organic matters in natural waters are not various in character. They are necessarily the detritus of the albuminoids which constitute the organic basis of life. Microscopic organisms in the water grow and multiply by the assimilation of this pabulum. Albuminoid ammonia which is thus lost from a water may be recovered from its living sediment. Free ammonia which disappears through the vital action of microscopic vegetation may be recovered as organic ammonia from the albuminoid tissues which have been formed. In general terms, it is the albumen of life which is the nitrogenous organic matter of natural waters. There are grounds, therefore, for assuming that the organic impurities of different waters may be comparable through the medium of the albuminoid ammonia which can be distilled from them. It is certain that in many waters the nitrogenous impurity is proportioned to the organic ammonia. Swamp water, which every one would avoid as morbiferous, has a high figure of albuminoid impurity; and this figure may be found in impure cisterns the water from which every one would hesitate to drink. In cisterns which are less foul, the water of which is declined by sensitive palates, the organic ammonia is correspondingly decreased. Waters which are universally accepted as wholesome yield but small quantities.

But for the fact that urea may not evolve ammonia when treated with the alkaline permanganate on account of its previous transformation into an ammoniacal salt, it might indeed be said that the unwholesomeness of a water is directly proportioned to the amount of its albuminoids. Deep wells may be polluted by urea and their contaminated waters may show as organically pure, not only by the absence of albuminoid ammonia but also by their failure to decolorize the permanganate, as in Judge Bond's well and that of the Galt House, Brownsville (Analyses 221 and 213). These cases, while preventing the albuminoid figures from being used as an expression of wholesomeness or pollution, usually present no difficulty to the analyst. Urea ferments so rapidly into carbonate of ammonia by taking up the elements of water that where there is ureal contamination there is generally an excess of free ammonia, as in Analysis No. 221, or, if the soil filtration removes this, imperfect oxidation remains to condemn the water, as in Analysis No. 213.

Professor Wanklyn formulates the results of his experience thus:

"If a water yield 0.00 parts of albuminoid ammonia per million, it may be passed as organically pure, despite of much free ammonia and chlorides; and if indeed the albuminoid ammonia amount to .02, or to less than .05 parts per million, the water belongs to the class of very pure water. When the albuminoid ammonia amounts to .05, then the proportion of free ammonia becomes an element in the calculation; and I should

be inclined to regard with some suspicion a water yielding a considerable quantity of free ammonia along with more than .05 parts of albuminoid ammonia per million.

"Free ammonia, however, being absent, or very small, a water should not be condemned unless the albuminoid ammonia reaches something like 0.10 part per million. Albuminoid ammonia above 0.10 per million begins to be a very suspicious sign; and over 0.15 it ought to condemn a water absolutely."

It will be observed that the recognition of the hygienic significance of free ammonia in the water provides for the detection of ureal impurity. Such formulæ should be regarded only as a generalization of the experience of the writer. As rules for guidance they cannot be implicitly followed, else would such samples as that of the Galt House well be pronounced organically pure. Each water must be thoroughly investigated and studied, with a full appreciation of the meaning of the various experimental results, instead of being judged by the result of this one process.

In well and spring waters and those contained in underground cisterns the object of the investigation is not a determination of the albuminoid matter, although a large figure should condemn the sample on account of diarrhœal, dysenteric, or febrile possibilities. It is the discovery of a leak which admits of surface washings either directly or with insufficient filtration through the soil. If such is found to exist the character of the leakage has to be investigated. Too often it is derived from neighboring vaults, sewers, cess-pools, sinks, or a soil saturated with the contamination incident to long continued occupation and unsanitary habits. In these cases the water is dangerous irrespective of its albuminoid ammonia. Typhoid fever and cholera, when the specific poisons are within the drainage area, may enter, no matter how small the leak, and be scattered widely with the water supply. The water may be wholesome in the mean time, but there is a possibility of danger, and sanitary science can only guard against disease by averting its possibilities. Such waters should therefore be condemned because of the leak—not because of the carbon or nitrogen which they contain, the permanganate which they decolorize, or the albuminoid ammonia which can be distilled from them. These are only parts of the evidence by which the leak is established.

Nevertheless, when Professor Wanklyn's limit of .015 part per 100,000 is reached in a well-water, that fact alone may be considered sufficient to condemn it, as it seems to afford proof of inadequate filtration and liability to specific contamination. When the spread of typhoid fever has so followed the distribution of water from a given source as to leave no doubt that the supply was connected with the propagation of the disease, albuminoid ammonia has usually been found in excess.

But when the subject of water supply is extended to embrace, in addition to wells, stored rain-water and surface collections, such as pond, lake, and river waters, a rigid adherence to a condemnation figure of .015 would exclude from use many waters which cannot be considered otherwise than wholesome. River samples collected in the Western Territories where sewage contamination was impossible gave in no case less than .014 part. Rain-water fresh from the clouds has seldom less than .010 part and may contain as much as .046 part. (Fort Preble, Portland, Me., May 1, 1879.) As typhoid poison is improbable in such waters, the albuminoid ammonia ceases to indicate the possibility of its occurrence. With large albuminoid figures in the water of the raised tanks of New Orleans there is a perfect immunity from typhoid fever. Specific poison being excluded, it would seem as if the evil effects of nitrogenous organic matters in water might be ascertained and their limit of wholesomeness be defined. This limit certainly cannot be far above .020 parts, because with more than this amount warm weather will develop a taint in the water which is appreciable by the senses.

But although the poisons of typhoid and possibly cholera are unlikely to be present in rain supplies, there appears warrant for believing that remittent fevers and dysentery may be developed by albuminoid or other matters contained in them. Practitioners in the south are confirmed in their belief of the water origin of many remittents occurring under conditions where exposure to malaria appears to be excluded. In four such cases specially investigated (Analyses 45, 46, 97, and 124) during the past autumn the yield of albuminoid ammonia from the water supply was large. In non-malarious mountain regions remittent fever occurs at all times and seasons which correspond with excess of impurity in the water. The albuminoids may not cause it any more than in well-water they cause typhoid. They accompany its cause, and when the resultant ammonia is in excess of .020 part, they may be viewed as a danger-signal indicating the increased probability of the presence of malarial poison. The febrile cause may be present in waters which yield less than this, but there is a greater likelihood of the presence of a specific impurity when the general impurity is great than when it is small. For these reasons it would appear advisable that the albuminoid ammonia in waters which are not exposed to sewage contamination should not be in excess of .020 part.

In discussing this subject heretofore, the writer has held the view that the nitrogenous matter in such waters was of vegetable origin. The history of the water which was closely investigated in many instances supports the opinion. There were no ni-

trites present, but their absence did not prove a vegetable origin, as observations made in the course of the analyses indicated that the oxidation of nitrogen depended less on the origin of the albuminoids than on the conditions to which they were exposed, of which filtration through or prolonged contact with the soil appeared to be one. But the absence of chlorine was suggestive ot a vegetable derivation.

Vegetable matter was observed by Wanklyn to give up its nitrogen as ammonia slowly. In examining laboratory notes on this point, it was found that in many cases where the organic matter was assuredly of a vegetable character, the albuminoid ammonia diminished by one-half in successive distillates of 50 c. c. Thus water from the swamps near New Orleans distilled .24, .12, .06, .03. The process was carried no further, as the object in view at the time was not a demonstration of the manner of evolution, but a determination of the total as bearing on quality. Wolf River water (Analysis 249), in which the possibility of animal matter is excluded by the surroundings of the water-course, yielded its organic ammonia in successive quantities of .10, .05, .025, .01. The deep well (Analysis 194) gave it up as follows: .16, .09, .04. This was one of the cases where it was considered injudicious to proceed further on account of violent bumping. On the other hand, waters which were assuredly contaminated by animal albuminoids, although vegetable matter might also be present, gave up the formed ammonia much more rapidly, each distillate containing only one-third, one-fourth, or even one-fifth of that found in its predecessor. The rapidity with which the process was conducted had no influence upon the proportion of ammonia in the distillates, provided no loss occurred from inefficient condensation. Many of these showed by their slight decolorizing action on the permanganate that the ratio of carbon must of necessity be small. At first it was supposed that the carbonaceous matter naturally assoc ated with vegetable albuminoids, or accidentally present along with animal matters, might interfere with the action causing the evolution to take place slowly, but several cases occurred (as in Analyses 94, 231, and 234) where with much carbonaceous matter the evolution was comparatively rapid. A difference in the character of the albuminoids appeared to be shown by the manner of evolution; and it might have been concluded that this difference consisted in their animal or vegetable nature but for the fact that the nitrogenous matters in rain yielded ammonia rapidly and would thus require to be set down as mainly of animal derivation. Rain-water at Memphis, December 3, 1879, gave up its organic ammonia in successive quantities of .035, .008; at New Orleans, March 3, 1880, in quantities of .10, .04, .01, and, in a second sample, .07, .025, .01. Some experiments were, therefore, instituted to clear up this point. Albumen from blood, and crude gluten from flour, were dried and dissolved in an alkaline solution. The vegetable matters extracted by water from sawdust, and those in a watery extract of fresh leaves (*sonchus oleraceus*) were also tested. The albumen solution, when fresh, yielded the organic ammonia more slowly than the animal matters of water and rather more rapidly than was conceived to be characteristic of vegetable albuminoids, the first three distillations yielding .220, .095, .050; but after having been exposed to the air for ten days so that putrefactive changes might be in progress the distillations were .30, .09, .05. The gluten when fresh distilled slowly, .26, .15, .8, in the first three distillates; at the end of eight days, .30, .15, .8. The sawdust infusion gave .030, .015, .005. The fresh leaves yielded .14, .047, .015, and, when the infusion had been exposed for ten days to putrefactive agencies, the evolution was little altered, .15, .05, .025. It was thus seen that while the gluten and the small quantity of albuminoids extracted from sawdust distilled slowly, the animal albumen was not characterized by the rapidity of its destruction. On the other hand, the fresh juices of the plant distilled rapidly, and the rate was not materially altered by putrefactive changes, while these changes increased the rapidity of evolution in the solutions of albumen and gluten. From these experiments it was conceived that the animal or vegetable nature of the albuminoids has little to do with the manner of the ammoniacal evolution; that the tendency in the albuminoids to change, whether progressive, as in the young and growing leaves, or retrogressive, as in the decaying solutions, accounts for differences in the manner in which the ammonia distils.

Rain-water as it falls from the clouds varies in the amount of its albuminoids. That which falls after a long dry season is usually very impure; such was the rain instanced above as having fallen at Fort Preble. On the other hand, if collected at the end of a shower of many hours' duration, the water may yield only .010 or .012 part. The organic ammonia of cistern water might therefore be expected to be frequently beyond the assumed limit of wholesomeness. But the albuminoids disappear from properly stored waters, as does the free ammonia, and probably from analogous causes. Cool, dark, clean, and wel lventilated cisterns will furnish a supply which yields only .003 part, although a highly charged rain may have entered there only a few days before. Any increase in the amount found is dependent either on foul accumulations in the cistern or on leakage. If from the latter cause the possibility of typhoid or other specific disease is as great as in the case of wells, but if assuredly from the former as much as .020 part is allowable, although by no means desirable.

The purification which takes place in raised tanks is less thorough. The albuminoid ammonia of the best waters is seldom under .010. Such is the case also with lake and pond waters. River water, as already stated, seldom contains less than .014 part, but when turbid this may be largely increased. Most of the increase is removed by sedimentation, the mineral particles carrying down with them suspended nitrogenous matters.

The issue of the distillation of the organic ammonia is thus seen to give very definite ideas with regard to the quality of a water. Where the albuminoids are in large quantity, that is, in excess of .020, the water should be condemned. This opinion is usually sustained by the large amount of oxygen required, by the blackening on ignition and by the loss of weight. Where the organic ammonia is in small quantity, not in excess of .005 part, the water is wholesome unless indications of the presence of urea are manifest. Where it ranges between .005 and .020 the recent history of the water must be known in order that a correct hygienic value may be attached to its quantity.

SECTION VII.

ON THE NITROUS ACID.

Albuminoids under certain conditions which are found in nature give oxygen compounds, nitrous and nitric acids, along with or instead of ammonia as the result of their decomposition; or ammonia having been formed in the first instance nitrites and nitrates may appear at its expense. This subject is exceedingly obscure. When moist and exposed to the atmosphere and a suitable temperature, nitrogenous organic matter retrogrades to inorganic forms, a free development of carbonate of ammonia signalizing its destruction. The carbon of the organic matter uniting with oxygen to the formation of an acid has been supposed to determine the alkaline union of nitrogen with hydrogen. But if the decomposing matter is in contact with a fixed alkali, nitrogen acids are formed which combine with it. When the putrefactive process is rapidly effected by a conjunction of favorable conditions in a neutral mass, the ammoniacal result is to be expected, but where it takes place slowly, nitrous acid may be formed, the alkalinity of the ammonia first produced disposing the residuum of nitrogen to an acid union. In these changes certain low organisms act an important part by means of their vitality. Schlœsing, Müntz, and Warrington have recently made it probable that the oxidation of nitrogen may have to be viewed as a chemico-vital result of the action of a special organism or nitric ferment.

It is doubtful if animal albuminoids are more prone to yield nitrites in their decomposition than those of vegetable derivation, although this is often stated as a characteristic difference between them. Pure vegetable extracts when putrefying will furnish a layer of nitrites on the surface of their mass. Nitrous acid, however, is more commonly found in water which has percolated through the soil than in rain-water, and as the animal waste in long occupied sites is a frequent impurity in wells, the nitrites have been referred to the oxidation of animal nitrogen. Nitrites and nitrates are also common in grave-yard waters. But nitrites are found in samples which have not filtered through the soil, and which could not have been contaminated by soil pollution, as in the water of the Gayoso Hotel cistern, Memphis (Analysis 100).

The probability appears to be that albuminoids, whether animal or vegetable, are prone to nitrous and nitric formation when the favorable conditions are presented. Filtration through the soil, by introducing the special ferment of nitrification, by modifying the oxygen supply, charging the water with alkaline carbonates, or offering lime carbonate to contact with the decomposing matters, contributes more or less to these conditions; and to such circumstances, rather than to peculiarity in the albuminoids, the nitrous production may be attributed. The nitrites of the Gayoso and a few other cisterns may be due to the lime lining of the underground reservoirs. No nitrites were found even in the foulest waters stored in cypress-wood cisterns; *i. e.*, none were found except in waters which had come in contact with the soil or with lime salts.

Nitrites and nitrates (excepting those formed from elementary nitrogen) in a water are thus, like ammonia, the harmless remains of previously organized substances. The water which contains any of them must have been at one time polluted with nitrogenous matter. The nitric acid and ammonia in rain result, in part at least, from the decomposition of the organic dust of the atmosphere. The same nitrogen compounds in terrestrial waters are derived from the breaking up of the organic matters which were precipitated with them, and of those with which they have been contaminated since reaching the surface.

The quantity of these products in a water is of importance as indicating the quantity of matter in which they originated; but a point of even greater interest to be determined is the proximity of the undecomposed matters to the water reservoir. If near, the water may at any time become noxious from the influx of unoxidized albuminoids, and certain epidemics of typhoid have shown that there is danger from specific poisons which may be of a less oxidizable character; germs, for instance, offering a

vital resistance to decomposing influences. Distance lessens the danger. The nitrogen compounds themselves aid in the solution of this question. Ammonia, as already shown, is uniformly present when the decomposition is in progress, and as it is at the same time exceedingly evanescent, its presence is significant of dangerous proximity. Nitrous acid implies the same danger, as it is a direct product of the decomposition; but as it is less prone to dissipation, it may in some cases have come from a greater distance than the ammoniacal contamination. Nitric acid, on the contrary, indicates a certain degree of remoteness. It is a higher oxide and more stable compound than the nitrous acid; its organic origin is therefore more remote. Nitrates in a water may have been of geologic derivation, organic once, but at a time so distant that they have no bearing on the quality of the water other than by augmenting the amount of the inorganic solids. In deep well waters the nitrogen of nitrates may be as thoroughly dissociated from its previous organic combinations and connections as is the chlorine of the sodium salt in sea water; but in surface waters, among which are classed the more or less impure ground waters, it assumes an importance in connection with the organic contamination. If nitrites coexist, the nitrates may indeed be viewed as adding to their quantity and increasing the suspicion with which the water is to be regarded.

Nitrous acid in a water is easily detected by means of iodized starch. As the test solution does not keep, a small quantity must be prepared in a beaker at the time of the experiment. Break up a few decigrams of starch in a little distilled water by means of a glass rod. Add 25 or 30 c. c. of boiling water and insert the beaker in the water bath for a minute or two. Dissolve a small fragment of potassic iodide in the liquid, and, when cold, it is ready for use.

Fill a large test tube with the water to be examined and a similar one with distilled water. If the color of the sample has not been noted up to this time it may be conveniently observed now and compared with that of the pure water in the other tube. Add a little of the iodized starch liquor to each, and then two or three drops of diluted sulphuric acid. The distilled water is unaffected by the addition of the acid. The other, if it contains nitrites, immediately develops a solid blue color. If a trace only is present a faint blue streak may be seen as the acid penetrates the volume of the liquid, or without this the sample may darken somewhat in its complexion. In these cases the presence of nitrous acid should be recorded, but it is needless to attempt its estimation. The qualitative test is so delicate that a quantitative experiment is only necessary when a definite blue color is produced.

The estimation is best effected, as suggested by Professor De Chaumont, by destroying the nitrous acid and determining the loss of deoxidizing power which corresponds with its destruction. A previous experiment (Section IV) has determined the quantity of permanganate decolorized by the oxidizable matters (nitrites included) which are contained in the sample. Nitrites are destroyed by boiling for twenty minutes with sulphuric acid; 200 c. c. of the water are therefore treated with 10 c. c. of the diluted acid and boiled. Loss by evaporation is made up by distilled water, and the 200 c. c. are acted on by permanganate at the boiling temperature and then treated with oxalic acid and permanganate again, as already described. The result gives the number of cubic centimeters of permanganate solution decolorized by the organic matter alone, and this deducted from the number used in the previous experiment gives the quantity which was decomposed by the nitrites. The volume of decolorized solution thus found is multiplied into its oxygen value, and from this the nitrous acid is calculated. Two atoms of oxygen are required to oxidize one molecule of nitrous acid; hence, 32 parts by weight of oxygen are equivalent to 76 parts of anhydrous acid, or 1 part to 2.375 parts. By multiplying the oxygen value of the permanganate used in the experiment by this number the quantity of nitrous acid is expressed. Thus, if 6 c. c. were decolorized originally and only 3 c. c. after the boiling which eliminates the nitrites, the entry would be as follows:

6 c. c. permanganate destroyed by all oxidizable matters.
3 c. c. permanganate destroyed by organic matter alone.

3 c. c. permanganate destroyed by nitrous acid.
.0976 mgrm. oxygen value of 1 c. c.

.2928 mgrm. oxygen used by nitrous acid in 200 c. c.
2.375 factor to convert oxygen into anhydrous acid.

14640
20496
8784
5856

2).6954000 nitrous anhydride in 200 c. c. sample.

.3477 nitrous acid per 100,000.

It may be that some of the organic matter is destroyed in certain cases by the boiling, which is intended to act only on the nitrites. To test this point several waters which were free from nitrous acid were treated as if it were present, but no loss of deoxidizing power was entailed upon them. This was suggested by the analysis of a Memphis spring water (Analysis 244) which yielded by the permanganate process slightly more nitrous acid than was consistent with the subsequent nitric acid determination. The experimental error, however, is believed to have occurred in the latter estimation.

On the other hand, the Beale street cistern water (Analysis 140) required so large a quantity of permanganate solution to oxidize its organic matter, that the persistence of nitrites seemed probable, notwithstanding the twenty minutes ebullition. A portion of this sample was therefore boiled for one hour before assuming that the destruction of its nitrites was completed, but the results agreed, showing not only that the shorter period sufficed to remove the nitrous acid but that the forty minutes extra boiling had exercised no decomposing influence on the organic matters.

This method of estimating the nitrites is a very convenient one for the water analyst, as it requires no extra apparatus or reagents, and may in fact be regarded as a part of the test by permanganate.

In the rain samples drawn from wooden tanks no nitrites were found, although in some much nitrogenous matter was present. The water No. 46 contained nearly as much albuminoid matters as the swamp water (Analysis 266). Nor were there any detected in the running streams. In the underground cisterns, however, traces were discovered, not only in those which admitted soil impurity by leakage, but in some, as Winfrey's, Jackson, Miss., and Gayoso Hotel, Memphis (Analyses 92 and 100), where the impurity was solely derived from the roof. They are found also in the well waters and in the springs.

As may be supposed from their derivation nitrites usually occur in waters the probable unwholesomeness of which is demonstrated by other evidence, but occasionally traces may be present, as in the well at Elliott, Miss. (Analysis 205), and others, in what must be considered a very fair drinking water. Here, as in the sound lime-lined cisterns instanced above, favorable conditions may have determined the formation of a trace of nitrous acid from the organic matter present in the water as it existed in the reservoir, and not from neighboring stores of decomposing substances.

SECTION VIII.

ON THE NITRIC ACID.

Nitric acid is found in minute quantities in the rainfall, and it is, therefore, liable to be encountered in similar traces in all water supplies, as they are derived more or less directly from this source.

The presence of nitrous acid in quantities too small for estimation is a matter of importance in water analysis, as they indicate changes which are, or have recently been, in progress. A delicate qualitative test like the iodized starch is, therefore, of great value. But with regard to nitrates, their more remote relationship to organic matter frequently divests their presence of any sinister meaning, while traces are deprived of importance by reason of their universality. Hence a test which is sensitive to the presence of such traces is undesirable, unless complemented by a quantitative process which will indicate correspondingly minute variations in the amount. Efforts have been made in this direction, but unsuccessfully. Brucine yields a rose-colored solution in the presence of the smallest trace of nitric acid, and the depth of color has been suggested as a means for accurately estimating the otherwise inappreciable quantities. But it is extremely difficult to obtain even a distilled water, which will not give the color by this test.

In the absence of a quantitative process which will deal accurately and readily with tenths and hundredths of a milligram, the most valuable qualitative test is necessarily one which will take no notice of the traces of nitric acid which may be said to be normal to potable waters, but which will indicate their presence when in excess of that normal. A test which practically fulfills these requirements is found in Sprengel's solution, which consists of one part of carbolic acid dissolved in four parts of sulphuric acid, and subsequently diluted with two parts of water. It forms a faintly-red solution when seen in mass, but is almost colorless when dropped on a white porcelain surface. As generally used by the writer, 50 c. c. of the water sample are evaporated on the water-bath in a porcelain capsule. When dry and cold, three or four drops of the test solution are added and trailed over the water-residue by tilting the capsule. If nitrates are present in quantity a dark blood-red or purplish-red color is developed on the trail of the test drops. If traces only are present, the color is fainter, so faint that it may be impossible to say whether the original color has been deepened or not. In some cases, also, the darkening produced by the sulphuric acid on organic matter obscures the reaction. But in spite of these

objections, the test is useful. If it distinctly testifies to the presence of nitrates, the operator can immediately proceed to the quantitative estimation. If it gives no sign of their presence, or leaves the matter doubtful, the quantitative test may be resorted to should the character of the water appear to require this investigation. Where there is a large loss on ignition which has not been satisfactorily accounted for, where nitrites are present, although in traces only, or where cistern waters show signs of leakage, the quantity of nitrates should be determined, although Sprengel's drops may be indefinite in their testimony.

The significance of the indications of this test will be understood by a reference to the following experiments. The nitric acid was added to the water in the form of potassic nitrate. The water was evaporated, and the residue treated as in dealing with ordinary water samples.

Milligrams anhydrous acid in 50 c. c. water	.05	No reaction.
	.10	Trace doubtful.
	.20	
	.30	Trace certain.
	.40	Nitric acid present.
	.50	
	.60	
	.70	
	.90	

It will be observed that cases where the result is doubtful contain from .2 to .4 parts per 100,000. A larger quantity of water might be evaporated for the application of Sprengel's test, by which the number of doubtful issues would be lessened. With a residue representing 200 c. c. of water, .05 to .10 part per 100,000 would limit the uncertain cases, while .15 part would give a decided affirmative. But in samples where it seems desirable to have the question settled with certainty, a quantitative experiment is necessary if the trace is verified. The increased quantity of the water when concentrated by evaporation is therefore better utilized by a method of treatment which determines not only the presence but the amount.

There are several processes by which nitric acid in a water residue may be estimated with approximative accuracy, but undoubtedly the most trustworthy are those which determine the acid from the volume of nitric oxide produced by its deoxidation. In Frankland and Armstrong's method the reduction is effected by mercury and strong sulphuric acid. The water sample, concentrated to a few cubic centimeters, is introduced into a glass tube over mercury. No air must be permitted to enter along with the liquid. The rinsings of the evaporating dish and the sulphuric acid are then added. If carbonic acid is liberated it must be removed. The lower end of the tube is closed by the thumb, and the contents are shaken, taking care that the lower stratum of mercury remains unbroken. In a few minutes the nitric oxide is disengaged, and may be measured, after noting the temperature and barometric pressure for the necessary corrections in its volume. For facilitating the introduction of the liquids the tube is furnished with a small cup and tap at its upper extremity.

In Tiemann's modification of Schultze's process, which was adopted in the analyses herein recorded, and which will therefore be given in detail, the reduction is accomplished by ferrous chloride in the presence of hydrochloric acid. The nitric oxide is collected over a solution of sodic hydrate, strength 10 per cent. The ferrous chloride is prepared by setting iron filings aside to dissolve in hydrochloric acid.

The apparatus required consists of a glass flask, having a capacity of 120 to 150 c. c. It must be clamped by its neck at such a height above the work table as will bring it within proper reach of the Bunsen flame. Its tightly-fitting rubber cork is perforated, for the passage of two tubes, 4 or 5 m. m. in diameter, which serve, one for the admission of the reagents, and the other for the exit of the nitric oxide.

The entrance tube projects through the cork into the flask for about 2 c. m., and is drawn to a small orifice at its internal extremity. Above the cork it is curved outwards and downwards for about 10 c. m., and is connected by a short rubber tube with a glass continuation 10 or 12 c. m. long. The outer extremity of this entrance tube is carried clear of the body of the flask by the curve in its upper part, and it hangs free somewhat below the level of the bottom of the flask.

The exit tube at its inner end does not project into the flask, but is cut off flush with the lower face of the cork. Above the cork the tube curves outwards and downwards on the opposite side of the flask from the other, and is connected by a short rubber tube with a glass continuation long enough to enable its free end to reach the table in the downward and outward direction, and to rest freely thereon. A slight upward curve is given to this extremity, that a stream of gas issuing from it may be delivered into a graduated tube inverted over it.

The rubber fittings must be perfectly air-tight, and a strong and reliable clip or pinch cock must be provided for the rubber portion of each of the tubes.

The receiver is a tube about 30 c. m. long and 1.2 c. m. in diameter, closed at one end.

It is graduated to tenths of a cubic centimeter. It is held in position over a shallow dish by means of a stand and clamp, which are placed at such a distance from the flask that the end of the delivery tube can rest in the dish or be inserted into the open mouth of the graduated receiving tube as required.

An ordinary wash bottle and a couple of conical test glasses should be within reach.

The volume of water proper for the experiment is decided by the probable quantity of nitrates present. If Sprengel's test yields no indication of their presence, one or two liters may be required. If traces have been doubtfully suggested, 800 c. c. should be used. With the trace certainly manifested, 600 c. c. may be sufficient, while with deep blood-red streaks on the 50 c. c. residue and considerable loss on ignition of the total solids, 400, 300, or 200 c. c. may suffice for the estimation. In any case, the measured quantity of water is evaporated to 50 c. c., and this concentration of the sample is transferred to the flask. The rubber cork with its fittings is securely inserted, the clips, if in position on the rubber tubes, are removed, and the Bunsen flame is applied. The contents of the flask are boiled vigorously by means of a large and steady flame, the object being to expel the atmospheric air by the aid of the escaping steam. While this exhaustion is in progress, the shallow dish is half filled with the sodic hydrate solution. The graduated tube is charged with the same solution, inverted into the dish, and secured in its position by the clamp-screw.

When the boiling has been continued for some time, and the liquid is reduced to one-half, the end of the longer delivery tube is immersed in the caustic solution in the shallow dish, that the escaping steam may be condensed therein. If the rubber portion of its tube be now compressed between the finger and thumb, the soda solution will rise promptly in the tube, and its impact be felt in the obcluded part. The pinch-cock is made to relieve the finger and thumb, and the free end of the tube is inserted into the mouth of the graduated receiver. The steam from the flask now escapes in a dense cloud from the short or entrance tube, the other being closed by the clip and the column of caustic solution.

The boiling is steadily continued until only about 10 c. c. remain in the flask, when, by a concerted movement of both hands, the rubber portion of the short tube is compressed, and the Bunsen flame removed. These acts should be simultaneous, as, if the heat be continued after the compression is applied, there is danger of an explosion, and if it be removed before the tube is closed, air may enter and vitiate the subsequent results. As the rubber tube is quite hot, the finger must be immediately relieved by the spring-clip.

There are now in the flask 10 c. c. of water, containing nitrates with an atmosphere of aqueous vapor, which is cut off from atmospheric intrusion by the clip on the short or entrance tube, and the clip and caustic column in the other. As the flask cools, its vacuous condition is manifested by flattening of the rubber tubes on the proximal side of the clips. The reagents remain to be introduced. The short tube is tilted up on its rubber portion as a hinge, and the part external to the pinch-cock is filled with water from the wash-bottle. The end of the tube is then immersed in the solution of ferrous chloride contained in a conical test glass. The pressure of the clip is eased slightly, to admit of the graudal introduction of, first, the column of water which filled the tube external to it, and, second, about 20 c. c. of the iron solution. Hydrochloric acid is then presented in a conical glass and a few cubic centimeters are permitted to follow the iron, as the iron followed the water, into the flask. When the introduction is accomplished, the tube remains guarded by the clip and a column of acid.

The Bunsen flame is now turned down quite low, and applied so as to heat the flask gently. Some bumping occurs, but it is not dangerous. The liquid darkens in color as oxidation progresses. In a few minutes the rubber tubing on the proximal side of the delivery clip begins to lose its flatness, becoming distended by the elasticity of the accumulating gases and vapors. When this takes place, the finger and thumb should be substituted for the clip, and when it is certain that the pressure from within is greater than the external pressure, the way is opened for the passage of the gases along the tube to the graduated receiver. Hydrochloric vapors, steam, and carbonic acid are retained by the caustic solution, while bubbles of nitric oxide rise and collect in the upper part of the inverted tube. As soon as these bubbles of permanent gas cease to be evolved, and the crackling noise produced by the union of sodium with distilled vapors becomes marked, the flame may be increased somewhat to drive over the last of the nitric oxide. In concluding the experiment, compression is made on the delivery tube, while at the same moment the flame is removed. When the fingers have been relieved by the clip, air may be admitted to the flask by the entrance tube, after which the cork is easily extracted.

The essential of success in this process is the exclusion of atmospheric air from the apparatus. Unless the rubber fittings are perfectly air-tight, failure only can result. The boiling which effects the exhaustion must be vigorous and steady. The flask must not be too large, nor the tubes connected with it. Experience shows that 50 c.c. in being reduced to 10 c. c. will effectually clear out the air from one of the size recommended. But before trusting to a newly-mounted set of fittings it is well to give them a blank trial to guarantee their soundness.

The graduated receiver with its nitric oxide and soda solution is transferred to a tall glass cylinder containing water, in which it is immersed for half an hour to reduce its temperature. At the expiration of that period the tube is raised by means of a forcep until the liquid within is on a level with the external water, when the volume of the gas is read. The temperature of the water is then taken and the barometric pressure noted.

Ruddy vapors of nitric peroxide fill that part of the tube which was occupied by the nitric oxide as soon as air is admitted by withdrawing the tube from the liquid in the cylinder.

The objective point of this experiment is the weight of the nitric oxide which has been formed. If the weight of a gas always increased in proportion to its volume, this could easily be obtained provided the relation of weight to volume were known, but with nitric oxide, as with all gases, a given weight increases in volume when subjected to higher temperatures and diminished pressure, and contracts when these conditions are reversed. The weight of a given volume of gas being known under certain influences which affect its tension, any other volume under investigation must be subjected to the same influences before its weight can be ascertained. But it is not necessary to arrange these conditions in practice, as the volume which the gas would occupy when influenced by them can be calculated. One liter of nitric oxide is known to weigh 1.344 grm. when no moisture is present, when the temperature is at 32° Fahr. (0° C.) and the atmospheric pressure 29.92 inches (760 mm). The gas which is contained in the graduated tube has no doubt a higher temperature than this; from the nature of its surroundings it is of necessity saturated with moisture, while the barometric pressure may be above or below the stated figure. To ascertain its weight the volume which it would occupy under the above standard conditions must first be obtained.

For all practical purposes it is assumed that gases expand equally for equal increments of heat, and according to Regnault's researches the expansion which takes place on raising the temperature from 32° Fahr. to 212° is .3665 part of the volume. This increase for an addition of 180° of heat makes the expansion for 1° for Fahrenheit's scale .002036, or $\frac{1}{491}$ of the original volume at 32°; in other words, 491 c. c. of gas at 32° Fahr. expand $\frac{1}{491}$ of their bulk and become 492 c. c. at 33° Fahr., 493 c. c. at 34° Fahr., and so on, increasing 1 c. c. for each additional degree above the melting point. Hence the contraction in the volume of a gas which is involved in the reduction of its temperature to 32° is calculated by subtracting as many $\frac{1}{491}$ths of its volume at 32° as there are degrees between that standard and its observed temperature. Thus, were it necessary to know what amount of condensation would follow a reduction from 62° to 32°—the difference between these temperatures is 30°—491 c. c. at 32° expand to 521 c. c. at 62°; hence the observed volume is to that which the gas would occupy if cooled to 32° Fahr. as 521 to 491. In less restricted terms the observed volume is to the required volume as

491 + the difference in temperature : 491.

Suppose the nitric oxide in the graduated receiver measures 10 c. c. at a temperature of 59° Fahr., its volume if reduced to 32° Fahr. would be 9.48 c. c.; for

518 : 491 : : 10 : 9.48.

The influence of the moisture with which the gas is saturated has now to be eliminated. The volume of nitric oxide was read when the liquids within and without the tube were on the same level, that is, when the tension or elastic force of the gas and aqueous vapor within held the atmospheric pressure in equilibrium. The known pressure exerted by the vapor at the observed temperature when deducted from the combined pressure (which equals that of the atmosphere) gives that exerted by the gas alone, and the volume of moist gas is to the volume of dry gas as the total pressure to that of the nitric oxide. A table of the elastic force of aqueous vapor at such temperatures as are probable in these nitric acid determinations is given below for convenience in making calculations. Thus, if the 10 c. c. of nitric oxide at 59° Fahr., which have been reduced to 9.48 c. c. at 32° Fahr., were measured under an atmospheric pressure of 29 inches of mercury, the volume occupied by the dry gas would be 9.317 c. c.; for

29.0 inches—elastic force of gas and vapor.
.5 inches—elastic force of vapor at 59° Fahr.

29 : 28.5 : : 9.48 : 9.317.

The volume of a gas expands under diminished and contracts under increased pressure. The alteration is proportioned to the pressure change but in the inverse ratio. If the volume be required at a given pressure, the

Given pressure : observed pressure : : observed volume : required volume.

Thus, the 10 c. c. which were measured under the conditions existing at the time, and which have been found to be equivalent to 9.317 c. c. of dry gas at 32° Fahr. and 29 inches of mercurial pressure, will be further reduced in volume by an increase of the pressure to 29.92 inches.

$$29.92 : 29 :: 9.317 : 9.03.$$

Ten cubic centimeters of nitric oxide collected over water at 59° Fahr. and 29 inches barometric pressure are thus seen to be equivalent to 9.03 c. c. of the dry gas at 32° Fahr. and 29.92 inches; but as the weight of a volume of dry nitric oxide under these latter conditions is known, that of the 9.03 c. c. is readily obtained.

The following formula consolidates these calculations:

V' = volume of dry gas at 32° Fahr. and 29.92 bar.
V = observed volume.
B = observed pressure.
p = pressure of aqueous vapor at observed temperature.
dt = number of degrees between 32° Fahr. and observed temperature.

$$V' = \frac{(B - p)\ 491\ V}{29.92\ (491 + dt)}$$

Thus, in the 10 c. c. which have already served as illustration

$$B - p = 28.5, \text{ and } dt = 27.$$

Therefore,

$$V' = \frac{28.5 \times 491 \times 10}{29.92 \times 518} = 9.03 \text{ c. c.}$$

In case the centigrade thermometer and millimetric scale of pressure are used, the volume at the observed temperature and pressure is reduced to that which would obtain at 0° C. and 760 mm. As there are only 100° of the centigrade scale between the melting and boiling points corresponding to the 180° Fahrenheit, the expansion of a gas for 1° is .003665 of its volume, or $\frac{1}{273}$ instead of $\frac{1}{491}$. Moreover, as the melting point is the zero of the scale, the slight complication introduced by Fahrenheit's 32° is eliminated, and the observed volume is to the volume which would be occupied at zero as 273 + the observed temperature to 273. The consolidated formula is as follows, wherein the letters and their significance are the same as already stated, except that t = temperature is substituted for dt = difference between 32° and the observed temperature.

$$V' = \frac{(B - p)\ 273\ V}{760\ (273 + t)}$$

In the 10 c. c. illustration the observed temperature was 15° C., and the barometric pressure 736.6 mm. The tension of the aqueous vapor is found by the table to be 12.7 mm. $B - p = 723.9$ and $273 + t = 288$.

$$V' = \frac{723.9 \times 273 \times 10}{760 \times 288} = 9.03.$$

Table of the elastic force of aqueous vapor at temperatures which are likely to occur in the determination of nitrates in water samples by the process described.

Degrees, Fahrenheit.	Inches.	Degrees, Fahrenheit.	Inches.	Degrees, Fahrenheit.	Inches.
40	.25	52	.39	64	.60
41	.26	53	.40	65	.62
42	.27	54	.42	66	.64
43	.28	55	.43	67	.66
44	.29	56	.45	68	.68
45	.30	57	.46	69	.71
46	.31	58	.48	70	.73
47	.32	59	.50	71	.76
48	.33	60	.52	72	.78
49	.35	61	.54	73	.81
50	.36	62	.56	74	.84
51	.37	63	.58	75	.87

Should the operator have a Fahrenheit thermometer with a barometer graduated in millimeters, or a centigrade thermometer with an English pressure scale, it will be useful to remember that centigrade degrees are converted into Fahrenheit by multiplying by $\frac{9}{5}$ and adding 32; and that multiplication by .03937 converts millimeters into inches.

Tension table in millimeters of mercury for centigrade degrees.

Degrees.	MM.	Degrees.	MM.	Degrees.	MM.
5.0	6.5	12.0	10.5	19.0	16.3
.5	6.8	.5	10.8	.5	16.9
6.0	7.0	13.0	11.2	20.0	17.4
.5	7.2	.5	11.5	.5	17.9
7.0	7.5	14.0	11.9	21.0	18.5
.5	7.7	.5	12.3	.5	19.1
8.0	8.0	15.0	12.7	22.0	19.7
.5	8.3	.5	13.1	.5	20.3
9.0	8.6	16.0	13.5	23.0	20.9
.5	8.9	.5	14.0	.5	21.5
10.0	9.2	17.0	14.4	24.0	22.3
.5	9.5	.5	14.9	.5	22.9
11.0	9.8	18.0	15.4	25.0	23.5
.5	10.1	.5	15.8	.5	24.3

In case of mixed instruments translation may be effected by the following rules: Fahrenheit degrees are converted into centigrade by deducting 32 and multiplying by $\frac{5}{9}$.

Multiplication by 25.4 converts inches into millimeters.

Having obtained the necessary data by which the weight of nitric oxide can be found, there remains for consideration the quantitative relation which this gas bears to the nitric acid from which it was evolved. One molecule of nitric anhydride gives up three atoms of oxygen in its deoxidation; hence, 108 parts by weight will yield 60 parts by weight of nitric oxide; but 1 c. c. of this gas is known to weigh 1.344 mgrms. at standard temperature and pressure. The following proportion will therefore give expression to the weight of anhydrous acid which corresponds to 1 c c. of nitric oxide:

$$60 : 108 :: 1.344 : 2.419.$$

Every cubic centimeter of gas evolved in the destruction of the nitrates testifies to the presence in the water of 2.419 mgrms. of anhydrous acid. The corrected number of cubic centimeters have therefore to be multiplied by this number for the quantity of nitric acid in the water used, and this result must be divided by the proper figure (depending on the volume of water employed) to express the acid in parts per 100,000. Thus, supposing the 10 c. c. of gas in the illustration to be derived from 400 c. c. of the water sample—

10 c. c. observed volume=9.03 c. c. at 0° C. and 760mm.
2.419 factor to convert cubic centimeters of nitric oxide into milligrams acid.

7257
217710

4) 21.84357 milligrams acid in 400 c. c.

5.461 nitric acid parts per 100,000.

If no nitrites have been found in the water the above entry is correct as it stands: but if nitrous acid is present its quantity, as determined by the permanganate process, must be expressed in terms of nitric acid and be deducted from the amount of that acid found. One molecule of nitrous acid requires two atoms of oxygen to complete its oxidation; hence, 76 parts by weight are equal to 108 of the higher oxide, or 1 part to 1.421. The parts of nitrous acid per 100,000 are multiplied by this number and the result deducted from the parts of nitric acid. Thus, supposing the permanganate process to have yielded .2 part—

5.461 parts. Total nitric acid found.
.2×1.421= .2842 parts nitric acid formed from nitrites.

5.1768 nitric acid of nitrates in parts per 100,000.

This process is tedious in detail, but in practice the time spent over it is very short. The calculations can be made in a few minutes by means of the formula. During the preliminary evaporation the operator is of course engaged in other work. Its accuracy has been frequently tested by the estimation of known weights of nitrates. There are few sources of error attending it, and these can easily be avoided. With a

simple and accurate process like this at command, no sanitary analysis should be considered complete which records the nitrates as present but undetermined.

As has been already stated, nitrates (with the exception of the ammonium salt formed by electric agency from the elementary atmospheric nitrogen) are the ultimate product of the oxidation of organic nitrogen either by direct chemical action or through the intervention of an organized ferment. The deleterious substances in which they originated no longer exist, so that a water from a deep well, for instance, may contain a large quantity without imputation on its wholesomeness, provided their presence is the only positive result developed by the analysis. But if nitrous acid is found to coexist, although in the merest trace, it connects the past of the nitrogen with the harmless present, and suggests the existence of a storehouse of organic decay within dangerous proximity to the water supply. The water at the time of collection may be pure, as determined by the permanganate solution and the albuminoid process, rendered so by the oxidation which takes place during the percolation through the soil, but in progress of time this filtration may become inefficient and unoxidized matter find its way into the well. This may happen at any time. Any local derangements in the interstitial circulation causing an increased flow, may sweep the recent and unchanged organic impurity into the water supply. Nor must it be forgotten that, although the evidence will not permit it to be affirmed as a fact, it is probable that specific poisons have a stability greater than that of non-specific discarded albuminoids, a stability which is suggestive of a vital resistance to oxidizing agencies and which may carry them into the water supply in full potency through the distance which is insufficient to complete the oxidation of nitrogen. The water may be good in such instances of incomplete oxidation, but the water supply—the well—is dangerous and should be condemned as decidedly as if present pollution were discoverable. The well, 86 Madison street, Memphis (Anaylsis 214), is an instance in point. It contains an organically pure water, but its nitrates and trace of nitrites, together with the chlorine, to be hereafter considered, bespeak surroundings which may pollute it at any moment.

In unwholesome well-waters in which nitrates are present, without nitrites there is usually other testimony against the water sufficient for its condemnation, such as the large amount of albuminoids or the presence of ammonia indicting their decomposition or the dissolution of urea.

SECTION IX.

ON THE CHLORINE.

Much unmerited importance is frequently attached to the amount of chlorine in a drinking-water. Of the various inorganic salts which are connected with animal life sodic chloride is the most striking because universally present. It is bound up in a vital combination with the albuminoids, and is set free in their disintegration. It is not evanescent like ammonia, nitrites, and even nitrates, but remains as a measure of existing animal waste, for the dilution of a sewage can be determined from the amount of its chlorine, or as a simple memorial of animal processes at one time active. Hence has arisen the idea of its importance in a sanitary view.

Waters have been condemned without a reference to their organic constitution, because they contained so many grains of chlorine per gallon, as if the sodic chloride was the chief and only witness necessary in the case. But it is not thus all-important. On the contrary, there are none of the investigations detailed above which do not convey more information concerning the organic character of a water than can be learned from the estimation of the chlorine. Loss on ignition, oxygen required, ammonia and albuminoid ammonia evolved, nitrites and nitrates present, all speak more definitely concerning the organic matter than the chlorine which was combined with it at one time. Nitrates, on account of their relation to organic matter, frequently cast by their presence a groundless doubt upon good water. So it is with chlorine. But the nitrates are often supplemented in their evidence by the presence of nitrous acid, while there is no connecting link between the chlorine of past and present contamination. Nevertheless its quantity may aid in the formation of an opinion concerning a given water. In all natural waters it is present, derived from the atmosphere in minute quantities in the rain, from the roof in cisterns, from the surface in running streams, and from the soil in deeper waters. It is clear that there can be no sewage contamination when it is present only in the traces normal to rain. This alone would entitle the chlorine estimation to a place in the sanitary analysis. When in larger quantity there may or may not be decomposing or recently decomposed animal matters in the water. This must be settled by the other processes of the analytical scheme, and if such organic contamination is present it may or may not be connected with the whole of the chlorine found. The chlorides of recent impurity may be swamped in the mass of those of older, of even geologic date. But when these older chlorides can be excluded by a consideration of the facts developed during the inves-

tigation, the value of the chlorine estimation may be summed up as follows: In a contaminated water where the chlorine figure is large an animal derivation is probable, while with the chlorine small a preponderance of matter of vegetable origin is almost certain. Compare, for instance, the analyses of the sewage and swamp waters of New Orleans (Analyses 266 and 267).

Chlorine is detected and estimated by means of a solution of argentic nitrate. The resulting chloride is insoluble in water and shows as a white haze, cloud, or curdy precipitate, according to the amount present. This test should be applied to a few cubic centimeters of the water, not to manifest the presence of chlorine, as that may be taken for granted, but to give a rough estimate of the quantity that the operator may know what volume of water will be convenient or necessary for the quantitative determination. If a dense cloud or curdy precipitate appears 25 or 50 c. c. may be taken. With a faint haze 100 c. c. will be necessary; this quantity should be evaporated to 10 c. c. as a preliminary to the estimation. When little or no reaction is manifest 200 or 400 c. c. should be evaporated to a small bulk to insure accuracy in dealing with the traces which are present.

When a water charged with chlorides and colored slightly with neutral potassic chromate is treated *guttatim* with the silver test, the white argentic chloride is formed so long as any chlorine remains unprecipitated. But as soon as the chlorine has been thrown down red argentic chromate appears and gives its color to the liquid. The silver unites with the chlorine in preference to the chromic acid, and it is only when enough has been added to combine with the former that the latter can exert its action on the test solution. The appearance of the red chromate therefore indicates that the precipitation of chloride is at an end, and the quantity of silver solution used in producing this effect is the measure of the chlorine present.

The strength of the test solution convenient for this operation should be such that the silver of 1 c. c. precipitates about 1 mgrm. of chlorine: 170 parts by weight of argentic nitrate are decomposed by 35.46 parts of chlorine or 4.794 parts by 1 part. The solution should therefore be made by dissolving 4.794 grms. in a litre of distilled water. But as the nitrate may not be pure, it is always advisable to determine the exact chlorine strength of the solution by means of known quantities of sodic chloride.

To accomplish this the burette which is intended for the delivery of the argentic reagent should be filled with the solution to be tested. This instrument should have a capacity of 30 c. c., and be graduated to tenths. The clip compressing the rubber on its beak should work easily, that the delivery of the solution may be under perfect control. A small quantity of the sodic chloride is carefully weighed. If more than 50 mgrms. are taken, the burette would have to be refilled during the experiment, which is unadvisable. The salt is dissolved in 10 c. c. of distilled water and colored by the addition of the neutral chromate. The conical test-glass containing this solution is brought under the burette and the silver reagent is dropped in, the contents of the glass being stirred after each addition until the red color indicates the precipitation of chlorine as at an end. The quantity withdrawn from the burette to effect this is noted, and the known quantity of chlorine in the test-glass is divided by it for the chlorine strength of each cubic centimeter of the argentic solution. Let it be supposed that 25 mgrms. of sodic chloride were dissolved for the experiment and that 16 c. c. were used. The salt contains 35.46 parts by weight of chlorine in every 58.46 parts, hence .6066 parts of its weight is chlorine. By multiplying the sodic chloride by this factor, the chlorine present is found to be 15.165 mgrms., and this divided by 16 shows each cubic centimeter of the silver solution to be equal to the precipitation of .947 mgrm. of chlorine. A second experiment should be performed to corroborate the accuracy of the first when the value of the silver solution may be marked upon the bottle containing it: 1 c. c. =.947 mgrm. chlorine.

Or, if the operator prefer, the silver solution may be made to precipitate exactly 1 mgrm. per cubic centimeter, by dissolving such a quantity of the argentic nitrate in the liter of water as will give a solution stronger than this, and then diluting it to the required strength. Thus, if 5.250 grms. are dissolved, and, when tested as above, 1 c. c. found to be equivalent to 1.038 mgrms. of chlorine, the dilution to 1 mgrm. per c. c., may be effected by taking as many cubic centimeters of this strong solution as contain 1,000 mgrms. in the case in point 963.4 c. c.; for—

1,038 mgrms.: 1,000 c. c. : 1,000 mgrms. :: 963.4 c. c.,

and adding distilled water to make up the liter. The accuracy of the resulting dilution should be determined by a third weighed quantity of the sodic chloride.

The potassic chromate should be free from traces of chlorine. One drop of the silver solution added to a few cubic centimeters of it should give the deep red color of the argentic chromate. In dealing with cistern waters, which have but a trace of chlorides, absolute purity on the part of the indicator is imperative, although in well waters largely charged with chlorine, the error introduced by a slight impurity in the chromate would be of no consequence.

From what has been said concerning the titration of the silver solution, the details

of the chlorine determination are obvious. The 25 or 50 c. c. of unconcentrated water or the concentration to 10 c. c., as the case may be, are colored by three or four drops of the chromate solution, and, if the chlorine is known to be large, the test solution may be dropped in rather freely at first, or so long as a white curd or cloud follows each addition; but as soon as the red chromate appears in the track of the penetrating drops, and its diffusion through the mass of the liquid by stirring is needful to promote its decomposition by the unprecipitated chlorides, it is better to proceed slowly, stirring after each drop and concluding the experiment when one falls which flushes the liquid with a tinge of permanent red. The quantity of silver solution used is noted, and an extra drop may then be added to the test-glass to develop the deep red of the chromate and prove the precipitation of the whole of the chlorine. If, however, the quantity of chlorine is unknown or probably small, one drop only should be permitted to fall when the glass is brought to the burette, and from the effects of its admixture with the liquid the operator can tell with what rapidity he may proceed with the additions.

There is no difficulty in defining the end of the process. The yellow liquid with its white cloud and sediment of argentic chloride is reddened by a drop of the nitrate; the red coloration is diffused by the motion of the glass-rod, and in its diffusion fades, leaving the color-status as before. Another drop is added, but the diffusion is not accompanied by the fading, and the former status is not restored. The liquid is left of a deeper color from the presence of argentic chromate in solution, as this salt is soluble to a small extent in water, and an extra drop will permeate it with the dark red particles.

The solubility of the chromate suggests the propriety, when very accurate determinations are required, of evaporating the water sample to a small bulk. Where the chlorides are so plentiful that 50 c. c. may be operated on without evaporation, the margin of error or uncertainty in definition produced by the solvent action is of no moment. In certain cases chlorine may be lost during evaporation. Magnesic chloride is destroyed at the boiling temperature, and part of its chlorine is dissipated, but this salt is seldom present in waters which contain so little chlorine as to render evaporation needful in its estimation. If there be doubt on this point in any case the sample should be rendered alkaline with potassic hydrate before evaporating and be made neutral afterwards. Acidity in the solution to be tested interferes with the definition by preventing the precipitation of the chromate.

Organic matters in concentrated samples may darken the liquid and intefere with the delicacy of the reaction. In such cases the evaporation may be carried to dryness, the residue ignited gently to destroy the organic substances, and the chlorides extracted by a little water for their estimation.

The number of cubic centimeters of silver solution used in the experiment is multiplied by the chlorine value of 1 c. c., as marked upon the bottle containing the reagent, and from the amount thus found in the volume of water employed, that existing in 100,000 parts is calculated.

Thus, supposing 50 c. c. of the sample to have required 10 c. c. of a silver solution of which 1 c. c. = .947 mgrm. chlorine: $.947 \times 10 \times 2 = 18.94$ parts chlorine in 100,000 parts of the water.

When the silver solution has been made so that 1 c. c. = 1 mgrm. of chlorine, the number of cubic centimeters expresses the chlorine in parts per 100,000 if 100 c. c. of water have been operated on; while if 50, 200, or 400 c. c. have been employed, the cubic centimeters of test solution have to be multiplied by 2 or divided by 2 or 4, as the case may be, to give standard expression to the result.

Rain-water contains traces of chlorine up to .05 part. The first part of a rainfall contains more than its latter part; and rain falling near the sea-coast will sometimes yield more than that precipitated on inland territory. Stored rain-waters which have no more than this quantity are undoubtedly free from all surface impurities, even from those which are the result of roof washing. When a cut-off is employed to throw aside the first washings from the shedding surface the chlorine figure does not mount higher than .10 (Analyses 30 and 31). Hence, if a cistern or tank water presents only this trace of chlorine its impurity must be derived chiefly, if not solely, from the atmosphere. The water may not be pure, for rain water, as we have seen, has a large amount of albuminoids, but the cut-off, which excludes the first fall with its larger amount of chlorine and the roof washings with the notable increase for which they are responsible, throws aside at the same time the accompanying albuminoids; the cistern is therefore probably free from organic accumulations, and permits of the purification which takes place during storage, so that chlorine in such traces is generally indicative of a pure water. When no effort is made to insure the rejection of the first washings, the impurities carried into the cistern will be accompanied by a proportionate increase in the chlorine, hence its quantity becomes to some extent a measure of the organic impurity. This increase seldom exceeds .25 or .3 part per 100,000. The impure water of the raised tank on the corner of Bourbon and Bienville streets, New Orleans (Analysis 46), contained as much as .35 part, but this was an unusual case.

Any chlorine in excess of .3 part in cistern waters probably indicates leakage from the soil, and its bearing on the wholesomeness of the water must be determined by the considerations which influence opinion in the case of shallow wells.

In waters which have come in contact with the soil the chlorine figure becomes higher. In river water it ranges from .1 to 1 part. Mississippi water has given the latter figure. The increase is usually accompanied by a corresponding addition to the organic contamination.

Lake water has a similar increase, but the range is greater. Where evaporation gives unusual aid in disposing of the inflow, the amount of chlorine and other inorganic substances may be so high as to render the water unfit for potable use.

Shallow wells, among which must be considered leaky, underground cisterns, have the chlorine varying from a few tenths of one part to 48.2 parts. The latter figure was obtained from a cistern at 150 Monroe street, Memphis (Analyis, 149). Chlorine in quantity is a suspicious sign in waters which percolate through the superficial layers, but so far its diagnostic value is supplanted by the general experience that water from such sources is suspicious from the character of the source. The soil in peopled districts is probably impure, and the purity of the water which filters through it to be collected in a shallow well depends on the efficiency of the mechanical filtration and oxidation which take place. Whether the water is purified or not the chlorine accompanies it. The thorough dissociation of the chlorine from its former organic connections must be demonstrated before the water can be approved. Even then, with sources of impurity within the area of drainage, the well should be condemned.

In deep wells and springs the chlorine is valueless as a part of the organic analysis. It has probably existed for a long time in the inorganic condition. If some recently organized chlorides are present the fact is not manifested by the chlorine estimation, but by some of the other processes in the analytical scheme.

SECTION X

ON THE MICROSCOPIC EXAMINATION.

The examination of the suspended matters, although placed last in order in the method of analysis, is one of the most important parts of the investigation. A thorough knowledge of these particulate substances, and of the significance of their presence, would render the sanitary examination of a water a microscopic study with chemical processes to assist in clearing up an occasional uncertainty, instead of as at present a chemical study with the microscope as an accessory.

All natural waters contain suspended matters which must be submitted to examination. Where they are invisible to the eye and do not interfere with the transparency of the liquid, microscopic investigation alone will suffice; but where they cause a turbidity it may be needful as well to determine their quantity and chemical character.

As soon as the water is received, measures must be taken to obtain its sediment. If the half gallon or more is contained in one vessel it should be shaken up to diffuse the sediment uniformly and be transferred to two bottles, each to contain one-half of the sample. The water in one with its diffused sediment is to be used in ascertaining the total solids, the oxygen required, the nitrous acid if any, and the ammonias. That in the other is permitted to settle, water being drawn from it by siphon when needful for the qualitative tests for nitrites and nitrates, and for the chlorine and nitric acid determinations of quantity, as the absence of the sediment in these experiments does not alter the results.

After one, two, or three days, as the case may be, the water becomes clear and the sediment lies in a smooth and well-defined layer at the bottom. During this sedimentation all solids, mineral and organic, of greater density than the water, descend or adhere to the sides of the bottle. They tend downward enveloping and carrying with them in their condensing cloud, many suspended matters which would have fallen but slowly, or not at all on account of their levity. The supernatant water is purified by the removal of the organic matter, living and dead, which had been in suspension. Even the organic matter in solution has been reduced in quantity by the growth of microscopic forms which have been precipitated with the mineral matters.

If any interest attaches to the quantity of sediment 100 c. c. of the clear water may be evaporated to dryness and weighed for the dissolved solids in the water, and this, when deducted from the previously ascertained total solids, will give the amount of sediment. The loss of weight on ignition may also be compared with that already recorded. If considered necessary to ascertain the character of the water when dissolved matters only are present, 500 c. c. may be treated by Wanklyn's process, and 200 c. c. by the permanganate and oxalic solutions. The difference between these results from the clear water and those previously obtained by the same processes will give better expression to the organic constitution of the sediment than the loss of

weight on ignition, and will show what can be done by sedimentation or mechanical filtration to improve the quality of the original sample.

Turbid waters have to be freed from their turbidity before they are admissible as drinking supplies. This is usually effected in settling reservoirs or by filtration. The quantity of a sediment determines the rate of its accumulation in sedimenting tanks and reservoirs and on the surface of filter-beds; but it is the character rather than the quantity which is of interest practically. If the mineral particles are so heavy that the cloud settles in a short time, the water, so far as sediment is concerned, and irrespective of its quantity, is a better sample than one which takes twice as long to clear. If the mineral particles, when layered over the surface of a filter, form an impervious stratum through which a continuance of the filtration is impossible, the water is a worse sample on account of its sediment than another which deposits more but does not choke the filter. Quantity is therefore secondary to quality. Sandy particles are easily removed from a water. They fall readily, forming a pervious layer. Particles of finely-divided clay, on the contrary, take long to subside, and line the bottom with an impervious stratum. Hence, a small quantity of clay suspended in a water detracts more from its value as a water supply than a large quantity of siliceous sediment, provided the water in both instances contains so much organic matter that purification by separation of the sediment must be effected before it can be used. Water turbid from clay may, however, be very free from organic impurity, as in the case of the wells at Duckhill, Miss. (Analyses 168 and 169), where the suspicions suggested by the uninviting appearance of the water were not sustained by analysis.

To obtain the sediment for microscopic use, any water which has not been siphoned off for analytical purposes must be removed until there remain only about 30 or 40 c. c., which are shaken up and tilted with the suspended matters into a conical glass, where sedimentation is again permitted to take place. The clear water is drawn off by means of a pipette; or it may be poured out of the glass if, as is usually the case, the sediment is not much disturbed by the motion, and a droplet of the residue is transferred to a slide for examination.

The appearances on the microscopic field are extremely complex. On the one slide there may be matter for long-continued study, matter which may be productive of much dissatisfaction to the observer from inability to comprehend its nature. But although thus complex when examined minutely, each sediment presents certain characteristics which are seen at a glance with ordinary powers and upon which the quality of the water may frequently be predicated.

The matters are mineral, organic, and vitalized.

The mineral consist of:

1st. Silica, which occurs in angular fragments, unaffected by acids. When these are the characteristic of the field the water is probably pure.

2d. Calcic carbonate, in angular pieces, which are readily discriminated by their effervescence when a trace of acid is insinuated beneath the cover. In such cases the water is probably hard.

3d. Clay, occurring in particles just visible on the field; when slightly out of focus they may appear as minute spherules, when aggregated by an accidental touch on the glass cover they may assume an obscurely organized appearance. They are unaffected by reagents. They may be present in pure waters, as in the Duckhill wells, and in the cistern 303 Cynthia street, Memphis (Analysis 112), where their presence led to the explanation that Wolf River water loaded with clay had been stored in the cistern two years before. Usually, however, clay particles in a water are accompanied by organic impurities.

4th. Carbonaceous particles, which may be regarded as inorganic, since combustion has dissolved their connection with the organism. They may be present in large quantity in pure cistern waters, which in consequence would be condemned by the permanganate process, if its results were accepted as final. (See Analysis 66.)

5th. Accidental inorganic substances as the ferric oxide in the cistern water from Algiers (Analysis 32), which was easily recognized by its amorphism and color, by its solubility in hydrochloric acid, and action with sulphocyanide.

A great variety of organic matters occur in the deposit. These are easily discriminated when fresh, but in the progress of disintegration and decay the histological characters become lost and their origin is of necessity obscured. That they are organic, however, may be determined in the absence of internal evidence by their difference from the usual forms of inorganic deposit, and by the activity of the microscopic life in their neighborhood. Those most frequent in their occurrence are fragments of woody tissue from the roof in cistern waters and from the wood-work in wells. The pitted tissue shows their derivation from cypress and pine. Fragments of straw, starch-cells, pollen-grains, &c., are of common occurrence in cistern waters, as also the cellular tissue, stomata, veinlets, &c., of broken up leaves. Dark-colored solid looking masses of woody tissue from the roots of trees when present in a well-water sediment lead to the expectation of vegetable impurity in the water. Cotton fibres were found in nearly all of the cistern waters examined, and in many of the

wells. Their prevalence in the atmosphere deprived their presence in the water of any sinister meaning. Wool and linen fibres may be washed from the roof into cisterns, but when found in well-waters inflow from the surface may be suspected. Fragments of human hair and epidermal scales suggest a direct surface leakage of dangerous character. Insect remains, such as the legs, antennæ, abdominal shell, portions of wing, scales of butterfly, &c., may be present in cisterns, indicating a corresponding degree of impurity in the water, and affording evidence of inefficient filtration in the case of well waters, or of their insufficient protection.

The germs of vitality are so universally diffused that, where there is food, development, growth and reproduction will ensue under ordinary circumstances. Temperature retards or accelerates, but the same change which promotes the growth of microscopic organisms induces in devitalized matters, the fermentative or putrefactive changes which transform their albuminoids from wholesome to unwholesome as regards their action on the human system. These growths may therefore be considered in many cases as measuring not the albuminoids of a water, but the condition of these albuminoids as to nocivity.

The vegetable kingdom furnishes the water sediment with the minute bacteria swarming from their gelatinous matrix. These would probably have been discovered in many cases in the examinations which are recorded hereafter had they been looked for with higher powers. They occurred occasionally, however, and are mentioned only when they constituted a striking or characteristic feature of the field. Their connection with the putrefactive process is universally accepted.

In Dr. Sanderson's Report of Researches on the Intimate Pathology of Contagion (in the thirteenth report of the medical officer of the Privy Council, London, 1871), a mode of testing the relative organic purity of waters is suggested. He found in his investigations into the origin and growth of bacteria that waters which show freedom from organic germs, not only under the microscrope but when viewed by the electric beam, are nevertheless capable of determining bacterial growth when added to a proper nutritive liquid. Pasteur's solution was used in the experiments. It consists of 10 parts of sugar .5 of tartrate of ammonia, .1 of yeast ash, and 100 of water. When boiled in a flask which has been purified by exposure to a temperature of 200° C. (392° Fahr.) in a hot-air oven the liquid will remain clear indefinitely, provided it is protected from atmospheric dust by a plug of cotton wool. But if a few drops of water are added to the solution by means of a pipette which has been purified by heat, a turbidity will occur in the course of a few days from the development and growth of innumerable bacteria and fungi. The length of time the test liquid remains clear and its subsequent cloudiness are suggested as a means for determining the relative zymotic properties of drinking waters.

This process is destitute of value as an indicator of the quantity of organic matter. There are few waters which will not yield positive results when so heated. Distilled water will determine the growth unless it has been recently boiled in a purified flask. But no claim of this kind has been advanced in its behalf. It is simply a method, and a good one, of determining the relative bacteroidal fecundity of two or more waters, and where the ordinary analytical examination fails to indicate a difference between samples which have been submitted for comparison, this test might be useful in determining a preference.

The palmellaceous algæ developed in their gelatinous fronds, together with the protococcus cells and zoospores have as much interest for the sanitary microscopist as the bacteroids. Vegetable organic matter is indicated when they are present. Their associates are amorphous, protoplasmic masses, and the vorticella.

The symmetrical forms of the desmids and diatoms are so frequently found as to deprive their presence of any value except where they constitute the characteristic of the field, as in pure well or spring waters. Impurity develops other forms of life which withdraws the attention of the observer from the occasional diatom.

The filamentous Oscillatoriaceæ and nostocs with their transverse markings and constrictions, and the other confervoid genera where the colored endochrome becomes converted into motile zoospores as in Zygnema Spirogyra, Zygogonium, Conferva, Œdogonium, and Chætophora, are so generally found in water that it is only where they become prominent as a sediment that excess of organic impurity may be suspected.

Of the animals found in water supplies, the Rotifera, the most common of which are Rotifer and Hydatina, the Entomostraca, Cypris, Cyclops, Daphnia, &c., the Arachnida, Macrobiotus, and Hydrachna, occur frequently in waters which experience as well as chemical investigation shows to be wholesome. If present in large numbers a corresponding impurity in the water is indicated, but when met accidentally and a second specimen is discovered only after the examination of several slides, the quality of the water need not be called in question.

The tentacled infusoria, such as Euglena and Peranema and the ciliated Acomia, Enchelys, and Alyscum, are also to be found in waters which give good results chemically. Oxytricha, Kerona, and Euplotes occur in less pure waters.

The flat worms, the Anguillula and the regularly ciliated Paramecia of which those most commonly met are the oblong compressed Paramecium with its oblique fold, the elongated Amphileptus, and the flask-shaped Lacrymaria, with its long neck and ciliated mouth, coincide with waters which would be condemned on chemical grounds. Sluggish Amœboids, as Amœba and Actinophrys, more active protoplasmic masses, as Monas, Cyclidium Cercomonas, &c., and a profusion of Vorticellæ in an active or encysted condition, are undoubtedly characteristic of an impure water.

Several instances occurred (Analyses 101, 214) where a water condemned by the chemical results gave no indication of impurity under the microscope. This must be attributed to the perfect sedimentation which had taken place in the well or cistern. In such cases no particles of decaying vegetation were found on the field. The sediment was *nil* or consisted of a few amorphous particles. Had the water been so disturbed in the act of drawing the sample as to have brought up some minute pieces of vegetable decay, those pieces would have been found surrounded with some of the forms above mentioned. Pure waters with vegetable tissues accidentally on the field have but little accompanying organic life. Impure waters, on the contrary, are generally full of it. Exceptional cases occur, some of which may be explained, as suggested above, by the perfection of the sedimentation, but in others the cause is obscure. Analysis 149, for instance, shows a dead field, and the mineral particles and vegetable matters brought up prove the non-existence of organic life not only in the submitted sample but in the well itself. It is true that in this case the inorganic solids which are large and mostly of a saline character might be suspected of an interference with development, but Analysis 222, which is similarly constituted although not so highly charged, gives a sediment which is full of organisms.

On the other hand, when a well which is liable to an impure inflow, as evidenced by the co-existence of nitrates and nitrites, furnishes a sample which is free from albuminoids and from oxidizable organic matter, the microscopic characters may give direct assurance that the water has not always been as pure as the sample submitted for analysis.

ANALYSES.

RAIN-WATERS STORED IN RAISED WOODEN TANKS.

[Results expressed in parts per 100,000.]

Number of analysis.	Sample.	Total solids.	Loss on ignition.	Free ammonia.	Organic ammonia.	Oxygen required for organic matter.	Nitrous acid.	Nitric acid.	Chlorine.	Microscopic appearances.
1	Rain-water collected in clean dishes during the first two hours of a heavy fall, 3.3 inches occurring after three or four weeks of dry weather. New Orleans, La., March 8, 1880.	....	....	.050	.030	.2104	....	....	....	Recent vegetable tissues variously broken up; cotton fibers; starch cells; confervoid filaments and many zoospores, fungi, and mineral fragments.
2	As No. 1, but collected after the fall had been four hours in progress.	....	....	.082	.021	....	....	....	....	Not examined.
3	Rain-water in clean dishes during the first three hours of the fall. New Orleans, La., March 12, 1880.	....	....	.058	.000	....	....	....	....	
4	As No. 3, but collected during the night of the remainder of the fall; much electrical disturbance.	....	....	.071	.012	....	....	....	....	
5	Rain collected in clean dishes from a washed roof. Somewhat dark in color from soot particles.	4.5	1.5	.076	.009	.2266	None	.065	.07	Mostly mineral crystals and soot.
6	111 Jefferson street, Memphis: Cistern clean and new; shingle roof; water clear and colorless; heavy rain storms on previous days.	5.5	4.0	.021	.012	.3110	...do....	.065	.025	Sediment small; soot and minute mineral particles.
7	Court building, second district, New Orleans: Slate roof; cypress cistern, under cover; nine years old; never cleaned; clear and colorless.	7.5	3.5	.022	.010	.1276	...do....	....	.25	
8	House of Good Shepherd, New Orleans: Cypress cistern; ten years old; cleaned one year ago; water clear and colorless.	5.5	3.5	.011	.010	.0777	...do....	....	.10	
9	278 Saint Charles street, New Orleans: Cistern twenty-five years old; cleaned ten years ago; water clear and colorless.	6.0	4.0	.044	.012	.0833	...do....	....	.10	
10	Lavergne street, Algiers: Cistern five years old, cleaned one year ago; clear and colorless.	3.0	2.0	.005	.011	.1387	...do....	....	.15	
11	McDonoughville, Algiers: Cistern six years old; clear and colorless.	5.5	1.5	.032	.007	.0722	...do....	....	.125	
12	Berlin street near Constance, New Orleans: Cistern 4,000 gallons; eighteen years old; slate roof; water clear and colorless.	4.0	1.5	.005	.011	.1165	...do....	....	.15	Some minute clay particles.
13	State House, New Orleans: Cistern under cover; ten years old; cleaned two years ago; clear and colorless.	6.0	3.0	.011	.012	.0721	...do....	....	.15	Carbonaceous particles and a few zoospores.

14	School No. 5, New Orleans: Cistern 15,000 gallons; five years old; never cleaned; slate roof; clear and colorless.	5.0	2.5	.010	.008	.0721	...do....	....	.125	
15	School No. 4, New Orleans: Cistern 15,000 gallons; four years old; never cleaned; slate roof; clear and colorless.	5.5	3.0	.012	.008	.0555	...do....	....	.125	Carbon particles, mineral *débris*, and a few zoospores.
16	Washington and Hampson streets, New Orleans: Cistern 2,500 gallons; covered; slate roof; clear and colorless.	2.0	1.5	.005	.010	.0944	...do....	....	.10	
17	Sisters of Mount Carmel, New Orleans: Cistern 30,000 gallons; seven years old; slate roof; clear and colorless.	6.0	5.0	.018	.009	.0833	...do....	....	.125	Carbon; fragments of decayed wood; zoospores and rotifers.
18	Third and Camp streets, New Orleans: 50 yards from the houses in which the yellow fever of 1879 broke out. An iron tank receives the water from a slate roof and fills the cistern by its overflow; clear and colorless.	6.0	2.0	.010	.010	.1165	...do....	....	.10	Almost none; mineral particles.
19	As last; the water is received by overflow from No. 18 and passes through a filtering stone to the delivery faucet; clear and colorless.	6.0	2.0	.010	.009	.0499	...do....	....	.10	
20	Morgan depot, New Orleans: 60,000 gallons; cistern six years old; never cleaned; covered; slate roof; clear and colorless.	6.0	3.0	.012	.011	.0222	...do....	....	.125	Cotton fibers; mineral matter; hydrachna.
21	28 Dryades street, New Orleans: Cistern six years old; never cleaned; but a cut-off in use for one year; clear and colorless.	7.0	2.0	.016	.012	.1554	...do....	....	.10	Mineral and carbonaceous particles and an occasional animalcule.
22	Horst and Nashville avenue, New Orleans: Cistern eleven years old; never cleaned; slate roof; colorless but faintly clouded.	7.5	3.0	.009	.013	.2997	...do....	....	.125	Mineral particles; soot and acomia.
23	Plaster oil works, New Orleans: Cistern 18,000 gallons; uncovered; never cleaned; slate roof; clear and colorless.	7.5	3.0	.017	.014	.1055	...do....	.104	.25	Soot and mineral particles; zoospores; fragments of wood, cotton and wool; cyclops.
24	Saint Philip's school, New Orleans: Cistern seven years old; never cleaned; slate roof; clear and colorless.	5.5	2.5	.024	.016	.0666	...do....	....	.15	Mineral matter, zoospores, and cyclops.
25	202–206 Baronne street, New Orleans: Cistern ten years old; cleaned three years ago; slate and tin roof; clear and colorless.	7.5	4.0	.096	.015	.2220	None.	....	.10	Much carbon, many infusoria and zoospores.
26	206 Baronne street, New Orleans: Cistern ten years old; cleaned three years ago; asphalt roof; clear and colorless.	10.0	5.5	.017	.019	.1776	... do ...	....	.125	Carbon, zoospores, protococcus, infusoria, as acomia, enchelys, &c.
27	Jackson Barracks, New Orleans: 1200 gallons; cleaned six years ago; shingle roof; clear and colorless.	5.0	1.5	.063	.022	.3718	... do....	....	.125	Carbon, sand, recent and disintegrated woody tissues, acomia, cyclops.
28	Third and Camp streets, New Orleans (General J. B. Hood): Cistern cleaned three years ago; slate roof; clear and colorless.	5.5	1.0	.005	.016	.0944	... do....	....	.125	A few sooty and mineral particles; rotifers.
29	162 Chestnut street, New Orleans: Cistern cleaned four years ago; shingle roof; clear and colorless.	7.0	2.0	.065	.017	.3774	... do....	....	.15	Mineral and sooty particles; rotifers.
30	158 Chestnut street, New Orleans: Cistern one year old; a cut-off in use; slate roof; old cork in demijohn containing the sample; clear and colorless.	5.5	1.0	.003	.018	.1942	... do ..	....	.10	Bacilli and bacteria, torula, oscillatoria and enchelys.
31	158 Chestnut street, New Orleans: From same roof as No. 30; cistern three years old, cleaned out one year ago, and a cut-off in use since then; clear and colorless.	5.0	1.0	.003	.016	.3163	... do....	....	.10	Bacilli and bacteria, torula, zoospores, and mineral matters.

RAIN-WATERS STORED IN RAISED WOODEN TANKS—Continued.

Number of analysis.	Sample.	Total solids.	Loss on ignition.	Free ammonia.	Organic ammonia.	Oxygen required for organic matter.	Nitrous acid.	Nitric acid.	Chlorine.	Microscopic appearances.
32	Front and Olivier streets, Algiers: Cistern one year old; slate roof; dark in color, somewhat cloudy and with rusty flocculi.	7.5	2.0	.011	.018	.0222	... do....	....	.125	Ferric oxide, enchelys, hydatina.
33	Eliza street, Algiers: Cistern four years old; cleaned sixteen days ago; shingle roof; clear and colorless.	5.0	2.0	.033	.018	.2719	... do....	....	.10	Soot and mineral matter; decayed vegetation and zoospores.
34	355 Gravier street, New Orleans (near ammonia works): Cistern three years old; slate roof; clear and colorless.	8.0	4.0	.130	.019	.2664	... do....	....	.125	Much vegetable matter, zoospores, protococcus, and an occasional rotifer.
35	26 Magnolia street, New Orleans (near ammonia works): Cistern cleaned one and a half years ago; clear, but dark in color.	12.5	6.0	.800	....	.7650	... do....	....	.35	Carbon and siliceous particles; zoospores; protococcus; arachinidians.
36	Public school, Short street, New Orleans: Cistern 3,000 gallons, two years old; shingle roof; clear and colorless.	5.5	1.5	.068	.017	.3996	... do....	....	.20	Decayed vegetable tissues; cotton and linen fibers; chœtophera and vorticella.
37	Public school, Berthe and Washington streets, New Orleans: Cistern 2,500 gallons, twelve years old; shingle roof; clear, but darkened.	5.0	2.0	.006	.020	.8491	... do....	....	.15	Vorticella and zoospores.
38	French Asylum, New Orleans: Cistern three years old; never cleaned; clear and colorless.	6.0	2.5	.016	.020	.0999	... do....	....	.20	Soot and cotton fibers; protococcus; zoospores; vorticella.
39	Police station, eighth precinct, Algiers: Cistern six years old; never cleaned; clear and colorless.	6.0	2.5	.065	.020	.3774	... do....	....	.05	Protococcus and euplotes.
40	Laurel street, New Orleans: Cistern eight years old; shingle roof; clear, but darkened.	5.5	3.5	.098	.026	.5772	... do....	....	.10	Carbon; zoospores; rotifers; very little vegetable *débris*; protococcus.
41	Saint Louis and Royal streets, New Orleans: Cistern ten years old; never cleaned; clear and colorless.	7.0	3.0	.036	.025	.1110	... do....	....	.175	Decaying vegetation, stylonychia, cercomonas and amœbæ.
42	Delaronde street, Algiers: Cistern two and a half years old; cleaned nine months ago; shingle roof; clear and colorless.	6.0	2.0	.026	.021	.3607	... do....	....	.225	Soot and decaying vegetation; anguillula in large numbers.
43	Saint Peter's street, Algiers: Cistern nine years old; cleaned two years ago; shingle roof; clear and colorless.	3.5	3.0	.117	[illegible]	[illegible]	... do....	....	.15	
44	Burdette near McCarthy street, New Orleans: Cistern sixteen years old; never cleaned; clear, but dark in color.	5.5	2.0	[illegible]	[illegible]	.6498	... do....	....	.125	Zoospores, cercomonas, vorticella, and decaying vegetation.

45	Mobile, Ala.: Sample sent by Dr. Gaines; clear and colorless.	....	....	.0006	.035	1.1998	... do....	....	....	Many cells, palmella, and coccochloris; a few infusoria; no vorticels, rotifers, or amœboids, but decaying vegetation and oscillatoria.
46	Bourbon and Bienville streets, New Orleans: Sample sent by Dr. C. B. White; clear and colorless.	6.5	1.5	.446	.070	.4162	... do....	....	.35	Bacteria, amœbæ, cercomonas, and vorticella in great profusion with but little solid organic *débris*.

RAIN-WATER IN UNDERGROUND CISTERNS.

47	Nuttall House, Holly Springs, Miss.: Cistern cleaned within a year; shingle roof; clear and colorless.	7.0	2.5	.002	.008	.2442	None.	....	.20	Soot and mineral particles.
48	Judge Davis, Holly Springs: Cistern cleaned three years ago; shingle roof; clear and colorless.	5.0	2.0	.001	.007	.1005	...do	....	.05	Soot and cotton fibers.
49	Court-House, Holly Springs: Cistern in good condition; tin roof; clear and colorless.	5.0	2.0	.001	.007	.1075	...do	....	.10	Soot and mineral particles.
50	Strictland, Holly Springs: Shingle roof; water passed through a charcoal filter; clear and colorless.	7.0	8.0	.000	.004	.1220	...do	....	.40	Sooty particles and zoospores.
51	Webb, Brownsville, Tenn.: Depth of cistern 15 feet; distance from vault 10 feet, on same level; clear and colorless.	7.0	3.0	.002	.003	.0244	...do	....	.10	Soot, cotton, and zoospores.
52	Alabama and Thornton avenue, Memphis: Front cistern; 200 feet from vault; clear and colorless.	4.0	1.5	.003	.009	.2041	...do	....	.05	Soot, mineral matter, zoospores, and mosquito larvæ.
53	Alabama and Thornton avenue, Memphis: Rear cistern; 100 feet from vault; 10 feet from vault of adjoining property; clear and colorless.	5.0	1.5	.004	.008	.2881	...do	....	.05	
54	Market and Third streets public school, Memphis: Cistern under the building, 15 feet deep; 45 feet from vaults; house used as yellow-fever hospital in 1878; clear and colorless.	11.5	4.5	.002	.005	.0875	...do	....	.25	Carbon and zoospores.
55	St. Mary's school, 364 Poplar street, Memphis: Two vaults 20 feet from cistern; clear and colorless.	3.0	1.5	.0004	.003	.0729	...do	....	.05	Sand, clay, cotton, and zoospores.
56	Public school, 178 Third street, Memphis: Clear and colorless.	4.0	1.5	.0008	.002	.0243	...do	....	.05	Sand.
57	121 Court street, Memphis: Clear and colorless..........	10.0	2.0	.002	.005	.0875	...do	....	.05	Sand and a few ciliated infusoria.
58	194 Main street, Memphis: Cistern in cellar, 90 feet from vault; clear but dark colored	3.0	1.0	.006	.005	.0972	...do	....	.05	Sand, zoospores, and acomia.
59	31–33 Poplar street, Memphis: Two vaults, 10 and 6 feet distant; clear but nearly straw-colored.	7.0	2.0	.007	.006	.0585	...do	....	.15	Clay particles chiefly.
60	396 Main street, Memphis: Cistern in cellar, 17 feet deep with 8½ feet water; vault 10 feet distant; clear but slightly darkened.	11.0	7.0	.008	.004	.3041	...do	....	.05	Decayed vegetation and infusoria.
61	342 Poplar street, Memphis: Vault 30 feet distant; clear and colorless.	4.0	2.0	.012	.0036	.0680	...do	.072	.20	Soot, mineral matter, and infusoria.
62	Franciscan convent, Memphis: Cistern 14½ feet deep with 8½ feet water; vault 100 feet distant; clear and colorless.	7.5	2.5	.001	.008	.4533	...do	....	.05	Mineral grains, clay particles, and a few infusoria.

RAIN-WATER IN UNDERGROUND CISTERNS—Continued.

Number of analysis.	Sample.	Total solids.	Loss on ignition.	Free ammonia.	Organic ammonia.	Oxygen required for organic matter.	Nitrous acid.	Nitric acid.	Chlorine.	Microscopic appearances.
63	544 Shelby street, Memphis: Cistern 18 feet deep with 12 feet water, in cellar of house; 40 feet distant from vault; clear and colorless.	10.0	4.0	.0008	.002	.0875	...do....	.086	.05	Soot, mineral particles, some decayed fragments of wood, and an occasional animalcule.
64	106 Adams street, Memphis: Cistern 4 feet deep; full; 50 feet from vault; clear and colorless.	16.0	4.0	.0008	.0025	.2144	...do....	....	.05	
65	104 Adams street, Memphis: Cistern 7 feet deep with 6 feet water; vault 45 feet distant; strong lime odor in cistern; clear and colorless.	11.0	5.0	.0004	.004	.2166	...do....	.130	.10	
66	Rayburn avenue, Memphis: Cistern twenty-four days old; contains 11 feet water; vault 70 feet distant; stable 145 feet distant.	16.0	5.0	.0025	.006	.4165	...do....	....	.05	Much woody tissue, soot, and a few infusoria.
67	355 Adams street, Memphis: Clear and colorless; no particulars.	10.5	1.5	.0008	.003	.0980	...do....	....	.05	Mineral grains and zoospores.
68	Chelsea school (north cistern), Memphis: 18 feet deep with 9 feet water; vault 106 feet distant; clear and colorless.	10.5	6.5	.001	.007	.2021	...do....	....	.175	Red clay particles and a few enchelys.
69	Chelsea school (south cistern), Memphis: 18 feet deep with 14 feet water; vault 123 feet distant; clear and colorless.	10.5	4.0	.002	.004	.1531	...do....	....	.175	Soot, mineral grains, and an occasional irregularly ciliated infusorian.
70	Linden street public school, Memphis, north cistern: 10 feet deep; vault 220 feet distant; clear and colorless.	6.5	4.5	.0006	.008	.3246	...do....	....	.05	As last, but with a few rotifers.
71	Linden street public school, Memphis, south cistern: Depth 10 feet with 8 feet water; vault 120 feet distant; clear and colorless.	4.5	3.0	.0004	.005	.2266	...do....	....	.05	Soot and mineral grains.
72	Clay street public school, Memphis: Depth 18 feet with 13 feet water; vault 62 feet distant; 30 feet deep and filled to 3 feet of surface; clear and colorless.	3.0	2.0	.001	.004	.2021	...do....	....	.05	
73	103 Adams street, Memphis: Vault 45 feet from cistern; an old unused well 8 feet distant; clear and colorless.	7.5	1.5	.007	.009	.2082	None.	....	.30	Mostly clay particles.
74	412 Poplar street, Memphis: Vault 21 feet distant; cistern 16 feet deep; vault 40 feet; clear, but slightly darkened.	9.5	3.5	.002	.007	.2313	....	....	.25	Clay particles and infusoria.
75	55 Poplar street, Memphis: Cistern 13 feet from vault; clear and colorless.	10.5	2.0	.012	.007	.2572	Trace.	.175	.10	Soot, mineral grains, and infusoria.

76	Police station, 40 Adams street, Memphis: 20 feet deep with 15 feet water; vault 30 feet distant, filled to 10 feet; mouth of vault on higher level than cistern; clear and colorless.	10.0	4.0	.0004	.003	.1225	None.	....	.15	Mineral matter, soot, infusoria, rotifers.
77	425 Wellington street, Memphis: Cistern 70 feet from privy; clear and colorless.	11.7	4.0	.001	.006	.1263	...do	....	.15	Much decaying wood and vegetable *débris*; irregularly ciliated infusoria and zoospores; cyclops.
78	184 Main street, Memphis: Cistern and privy vault in cellar of house; 6 feet between them; clear and colorless.	3.0	2.0	.002	.007	.0340	...do	.093	.10	
79	260 Vance street, Memphis (No. 1): 60 feet from vault; clear and colorless.	7.5	5.0	.001	.007	.1506	...do	....	.20	
80	260 Vance street, Memphis (No. 2): 15 feet from deep vault; clear and colorless.	7.0	3.0	.0006	.005	.2138	...do	....	.20	Woody tissue and decaying vegetation; ciliated infusoria and rotifers.
81	190 Main street, Memphis: 25 feet from vault; clear and colorless.	8.0	4.0	.001	.008	.3402	...do	....	.10	
82	336 Main street, Memphis: Cistern 37 years old, cleaned two years ago; water low at present and much sediment brought up with it; vault and cistern both in cellar; clear and colorless.	11.0	2.0	.002	.005	.0729	...do	....	.20	Many infusoria, lacrymaria, trachelius, and vorticels among much vegetable decay.
83	103 Main street, Memphis: Cistern 16 feet deep with 5 feet of water; vault 14 feet distant, 18 feet deep with contents 8 feet from surface; clear and colorless.	3.0	1.0	.0024	.008	.3402	...do	....	.10	Soot, decayed leaves, infusoria, and rotifers.
84	Public school, Court and Third streets, Memphis: Distance from vaults not stated; clear and colorless.	13.5	3.5	.002	.005	.1020	...do	.219	.10	Broken up vegetable matter with a few infusoria, and some specimens of anguillula.
85	Peabody school, Memphis: Two cisterns connected by a pipe; 18 feet deep with 6 feet of water; nearest vault 20 feet distant 25 feet deep; depth of contents 10 feet; ground water rises and falls in vaults with the stage of the Mississippi River; clear and colorless.	14.5	8.0	.003	.007	.1117	...do	.197	.15	Much infusorial life; paramecia and but little organic *débris*.
86	282 Adams street: Two vaults 55 and 85 feet distant from cistern and on same level; clear and colorless.	33.0	4.0	.017	.003	.1080	...do	.072	8.85	A few cotton fibers and confervoid filaments.
87	Linden and Cynthia streets, Memphis: No particulars furnished; clear and colorless.	6.5	3.5	.003	.010	.4165	None.	....	.05	Fragments of woody tissue and other vegetable *débris*; small in quantity, yet with many infusoria.
88	Institute for the Blind, Jackson, Miss.: Faintly smoky; shingle roof.	7.0	3.0	.027	.012	1.0650	...do	.062	.10	Much soot and woody tissue: zoospores and infusoria.
89	15 Jessamine street, Memphis: No particulars; clear and colorless.	7.0	3.0	.0012	.016	.5873	...do	....	.15	Cotton fibers, soot, mineral particles, and a few infusoria.
90	Shelton House, Brandon, Miss.: Shingle roof; no vaults near; clear and colorless.	5.5	2.0	.003	.022	.4530	...do	....	.15	
91	337 Adams street, Memphis: No particulars; faintly cloudy.	7.0	3.0	.062	.011	.1225	...do	....	.45	Clay particles, much decaying vegetation, and many infusoria.
92	Capitol street, Jackson, Miss.: Shingle roof; vaults 30 feet distant; clear and colorless.	6.0	2.5	.015	.028	.5878	.061	....	.05	Decaying vegetation and many rotifers.
93	Mansion House, Payne's Place, Miss.: Slate roof; no vaults near; clear and colorless.	8.0	2.5	.004	.023	.3761	None.	....	.10	
94	Overseer's House, Payne's Place, Miss.: Shingle roof; no vaults; clear but dark colored.	9.0	3.0	.002	.026	1.2750	...do	....	.10	Decaying vegetation and vorticels.
95	175–179 Main street, Memphis: Cistern in yard 30 feet from vault; straw-colored.	7.7	4.7	.0006	.010	.4811	...do	....	.10	

RAIN-WATER IN UNDERGROUND CISTERNS—Continued.

Number of analysis.	Samples.	Total solids.	Loss on ignition.	Free ammonia.	Organic ammonia.	Oxygen required for organic matter.	Nitrous acid.	Nitric acid.	Chlorine.	Microscopic appearances.
96	86 Adams street, Memphis: 100 feet from vault; clear and colorless.	11.0	5.0	.004	.011	.4410	Trace.	....	.10	Soot, mineral matter, woody tissue, lacrymaria, and rotifers.
97	Farish street, Jackson, Miss.: Stable 30 feet distant; shingle roof; smoky.	6.0	3.0	.008	.023	.7132	None.	....	.20	Carbon, clay, ferric oxide, daphnia, euglena, and vorticels.
98	100 Front street, Memphis: 15 feet from vault on east, 12 feet from vault on west, and 10 feet from stable on north; clear and colorless.	8.0	2.0	.007	.019	.4131	...do	.072	.10	Sandy particles, decaying wood, and many infusoria.
99	4 Jackson street, Memphis: Cistern 16½ feet deep with 5 feet of water; vault 5 feet distant, 6 feet deep, 2½ feet of contents; stable 30 feet distant; clear and colorless.	7.0	4.0	.0004	.020	.5054	...do	....	.20	Decaying vegetation and vast numbers of infusoria.
100	Old Gayoso Hotel, Memphis: 18 feet deep, 9 feet water; no vaults; clear, but somewhat dark.	14.0	5.0	.031	.020	.6512	Trace.	....	.25	
101	152 Main street, Memphis: 20 feet from vault...........	8.0	3.0	.061	.017	.4082	None.	.072	.125	Sediment almost nill; only a few amorphous particles and zoospores.
102	Deaf and Dumb Asylum, Jackson, Miss.: Vault 150 feet distant; shingle roof; clear and colorless.	15.0	2.0	.001	.008	.2979	None.	....	.675	Soot, sand, and wood fragments.
103	Penitentiary, Jackson, Miss.: Shingle and slate roof; clear and colorless.	9.0	2.0	.007	.007	.2051	...do	....	.40	Vegetable *débris* and zoospores.
104	Virdin's store, Jackson, Miss.: Semi-public cistern, much used; clear and colorless.	21.0	6.0	.001	.007	.2784	...do	....	1.30	Chiefly cotton fibres and soot.
105	Lemly's store, Jackson, Miss.: Not cleaned in ten years; clear and colorless.	16.0	3.0	.001	.007	.1221	...do	....	.35	Soot, cotton, decayed vegetation, and zoospores.
106	Old Bowman House, Jackson, Miss.: Clear and colorless	73.0	9.0	.0008	.009	.1807	...do	....	6.40	Decayed vegetation and irregularly ciliated infusoria.
107	273 Beale street, Memphis: 30 feet from vault; clear and colorless.	28.5	4.0	.0006	.005	.0874	...do	....	1.10	
108	Saint Agnes school, Memphis: 40 feet from vault; clear and colorless.	10.0	2.0	.0008	.006	.0777	...do	....	.275	
109	38 Poplar street, Memphis: Cistern in yard 5 feet from vault; clear and colorless.	8.5	2.5	.0006	.005	.0593	...do	....	.50	Sediment small; a few infusoria.
110	196 Third street, Memphis: 25 feet from vault; clear and colorless.	16.0	3.0	.002	.003	.1403	...do	....	1.30	
111	63 Linden street, Memphis; Clear and colorless.........	14.5	4.0	.023	.004	.2721	...do	.072	.55	Mineral particles chiefly.
112	303 Cynthia street, Memphis: 30 feet from vault, which is full and in bad condition; water slightly clouded; cistern cleaned one month ago.	18.0	4.0	.004	.007	.1362	...do	....	3.00	Mostly fine clay.

113	Pontotoc and Clinton streets, Memphis: 50 feet from deep vault; clear and colorless.	21.0	5.0	.001	.006	.1409	...do...	....	1.35	Much decaying vegetation and many infusoria.
114	367 Adams street, Memphis: 60 feet from vault; clear and colorless.	26.0	15.0	.0006	.005	.1776	...do....	....	2.50	Mineral matters only.
115	11 Jessamine street, Memphis: 35 feet from cess-pool; clear and colorless.	10.0	6.0	.002	.007	.1225	...do....	....	.30	Vegetable matter and a few infusoria.
116	Spengler House, Jackson, Miss.: Sinks 45 feet distant and on lower level; clear and colorless.	22.0	4.0	.006	.010	.1514	None.	....	1.30	Soot, cotton, and mineral grains.
117	Wirt Johnson, Jackson, Miss.: Faintly smoky	8.0	2.0	.027	.013	.3663	...do....	....	.30	Vegetable *débris*, zoospores, and a few animalcules.
118	Mason's, one mile west of Jackson, Miss.: Vault 90 feet distant; clear and colorless.	14.0	3.0	.007	.011	.2638	...do....	....	.80	Cotton fibers, woody tissue and decayed leaves, mineral grains, and many infusoria.
119	Taylor's, Holly Springs, Miss.: Clear and colorless	8.0	2.0	.007	.015	.4934	...do....	....	.60	Soot, vegetable matter, zoospores, and infusoria.
120	37-39 Monroe street, Memphis: Privy 40 feet distant, with sewer connections; stable 15 feet distant, and separated from cistern by a brick wall; faintly turbid.	13.5	4.5	.0004	.005	.0632	...do....	.062	.30	Much vegetable decay; infusoria irregularly ciliated and vorticels.
121	533 Hernando Road, Memphis: Clear and colorless	14.0	6.5	.0004	.007	.3207	...do....	....	.35	A large quantity of cotton entangling decaying vegetable matter, mineral grains, many infusoria, and some vorticels.
122	13½ Winchester street, Memphis: Cistern under floor of basement, 12 feet from vault; clear and colorless.	8.0	4.0	.013	.009	.1750	...do....	.108	.40	Some woody tissue and a large number of infusoria.
123	President street, Jackson, Miss.: Stables and sinks 200 yards distant; faintly smoky.	65.0	8.0	.003	.029	.3077	.0579	....	5.95	Vegetable *débris* and stylonychia.
124	West Jackson, Miss. (Hull's): No sinks or stables near; clear but dark-colored.	45.0	8.0	.001	.024	.5910	None.	... .	4.00	Cotton fibers, mineral grains, decaying vegetation; filamentous algæ; zoospores.
125	Dr. Heywood, Brownsville, Tenn.: Clear but dark-colored.	21.0	8.0	.001	.040	.2149	...do....	....	3.00	Sooty particles and much woody tissue; anguillula and amœboids.
126	313-317 Second street, Memphis: Faintly clouded and tinged with yellow; 5 feet from two old covered vaults and partly under floor of a stable.	8.0	2.0	.005	.011	.3450	...do....	.124	1.30	Sediment small; decaying vegetation and vast numbers of infusoria.
127	49 Promenade street, Memphis: Situated between four vaults, 17 feet distant from each; clear and colorless..	31.0	10.0	.057	.014	.3159	Trace.	1.954	2.35	Very small and chiefly mineral, with an occasional animalcule.
128	106 Vance street, Memphis: Nearest vault 10 feet distant; clear and colorless.	93.0	26.0	.002	.018	.3110	None.	7.818	7.20	Sediment slight, but many bacilli and paramecia.
129	12 Adams street, Memphis: 5 feet from a vault, which is 40 feet deep and filled to within 2 feet of surface; straw-colored but clear.	12.0	5.5	.016	.009	.0735	...do....	.108	.75	Minute clay particles and a few infusoria.
130	117 Court street, Memphis: No particulars; clear and colorless.	24.0	9.0	.001	.007	.1701	...do...	1.954	1.70	Sediment small, some broken down woody tissue, and paramecia in large numbers.
131	324 Second street, Memphis: Clear and colorless	9.5	5.5	.003	.009	.1555	...do....	.217	.75	Little decaying matter, but vast numbers of paramecia, trachelius, &c.
132	338 Linden street, Memphis: Clear and colorless	25.0	7.5	.005	.006	.2572	...do....	.271	3.25	
133	453 Orleans street, Memphis: Clear and colorless.......	21.0	5.5	.007	.015	.6609	...do....	.531	1.10	Much soot, vegetable decay, and infusoria.
134	321 Adams street, Memphis: Two vaults on the lot, one very foul; clear and colorless.	72.5	15.0	.001	.007	.1776	...do....	4.396	5.5	Sediment small, swarming with infusoria; some mineral grains and wood fragments.
135	106 Union street, Memphis: Clear and colorless	29.0	13.0	.002	.010	.0875	...do....	.549	2.7	
136	345 Poplar street, Memphis: 45 feet from vault; clear and colorless.	20.0	7.0	.002	.008	.2381	...do....	.145	.75	
137	67 and 69 Adams street, Memphis: Clear and colorless; vaults in close proximity.	47.0	26.0	1.450	.030	.3514	.3146	2.761	7.9	Sediment small; vast numbers of infusoria, amœba.

RAIN-WATER IN UNDERGROUND CISTERNS—Continued.

Number of analysis.	Sample.	Total solids.	Loss on ignition.	Free ammonia.	Organic ammonia.	Oxygen required for organic matter.	Nitrous acid.	Nitric acid.	Chlorine.	Microscopic appearances.
138	83 Beale street, Memphis: 30 feet from vault; water clear but with woody fragments, which readily subside.	12.0	2.0	.001	.007	.1458	None.	.338	.30	Much decaying wood, infusoria, vorticels.
139	67 Beale street, Memphis: 9 feet from vault; water clear, but with mosquito larvæ present.	19.0	4.0	.001	.024	.2575	...do	.169	1.60	Chiefly mosquito *débris* and animalcules.
140	71 Beale street, Memphis: 8 feet from vault; cloudy and yellowish.	97.0	16.0	.359	.165	1.1421	4.075	1.631	5.95	Minute sand particles and bacteria.
141	147 Robeson street, Memphis: Vault 32 feet distant; clear and colorless.	23.0	12.0	.0006	.008	.2752	None ...	.378	3.20	Sediment small; soot and a few infusoria.
142	60 Mill street, Memphis: Depth 13 feet, with 11 feet of water; vault 10 feet distant, 15 feet deep, and full; water clear and colorless.	26.5	5.0	.005	.020	.5635	...do	1.375	3.70	Vorticella; sediment slight.
143	302 Poplar street, Memphis: Depth 20 feet, with 13½ feet of water; vault 45 feet distant, 20 feet deep, and filled to 1½ feet of surface; clear and colorless.	43.0	13.0	.001	.014	.5083	...do	1.134	5.20	Euglena, paramecia, turbellaria, and vorticella.
144	North Front street, Memphis: Depth 15 feet, with 13 feet of water; vault 20 feet and filled; clear and colorless.	104.0	53.0	.002	.020	.4349	...do	10.756	7.20	Sand, fragments of wood, euglena, and cyclops.
145	18 Bradford street, Memphis: Depth 9 feet, with 3 feet of water; vault 30 feet distant, 10 feet deep, and 3 feet of contents.	37.5	16.0	.002	.038	.7289	...do	.576	7.40	Much organic *débris* and vast numbers of infusoria and vorticella.
146	270 Poplar street, Memphis: Depth 16 feet, with 11½ feet of water; vault 42 feet distant, 20 feet deep, and 18½ feet of contents; stable adjoining vault; faintly clouded.	64.0	30.0	.0008	.009	.0673	...do	.113	7.60	Clay, cotton, anguillula, and infusoria.
147	Morgan street, Memphis: Depth 9 feet, of water 5½ feet; vault 25 feet distant, 10 feet deep, and filled; stable 25 feet distant; clear and colorless.	71.0	23.0	.044	.032	.0798	...do	7.161	8.80	Clay particles and many infusoria.
148	178–180 Poplar street, Memphis: Depth 11 feet, with 7 feet of water; vault 65 feet distant, 12 feet deep, with 7 feet of contents; stable adjoining vault; clear and colorless.	92.0	25.5	.001	.012	.2327	...do	4.645	13.40	Clay particles and many infusoria.
149	150 Monroe street, Memphis: Depth 13 feet, with 4 feet of water; vault 65 feet distant, 15 feet deep, 9 feet of contents; clear and colorless.	325.0	132.0	.003	.021	.4593	...do	23.400	48.20	Sand, cotton, wood, but no living forms.

WELL-WATERS.

150	Dr. M. Lauren, Brandon, Miss.: 24 feet deep; 2 feet of water; no stables or vaults; clear and colorless.	26.0	3.0	.0012	.007	.1563	None.	None.	.60	Chiefly mineral detritus.
151	Dr. Hughes, Grenada, Miss.: 25 feet deep; 25 yards from privy; clear and colorless.	38.0	4.0	.001	.005	.0440	...do	..do ...	8.8	
152	Ed. G. Payne, Grenada, Miss.: 30 feet deep, with 3 feet water; surface privy 30 yards distant; slightly clouded.	36.0	4.0	.001	.007	.1025	...do	..do ...	8.8	Mineral matter, a little decayed vegetation, and a few irregularly ciliated infusoria.
153	Female College, Grenada, Miss.: 24 feet deep, with 2½ feet water; 90 feet from nearest surface privy; clear and colorless.	44.0	4.0	.001	.008	.0439	...do	..do ...	7.8	
154	Sherman, Grenada, Miss.: 18 feet deep, with 3½ feet water; surface privy 150 feet distant; clear and colorless.	40.0	4.0	.0012	.005	.0586	...do	..do ...	17.0	As last, but with rotifers also.
155	Public Square, Grenada, Miss.: 32 feet deep, with 4½ feet water; no privies or stables; clear and colorless.	36.0	3.0	.001	.005	.0244	..do	..do ...	11.2	
156	Lake, Grenada, Miss.: 24 feet deep, with 4 feet water; 30 feet from surface privy; clear and colorless.	19.0	2.5	.001	.008	.0048	...do	..do ...	5.8	Mineral particles and cotton fibers.
157	Thomas, Grenada, Miss.: 18 feet deep, with 2 feet water; 50 feet from privy; clear and colorless.	8.0	1.5	.001	.005	.0048	...do	..do ...	3.0	
158	Mullins, Grenada, Miss.: 23 feet deep, with 2 feet water; 85 feet from privy; clear and colorless.	60.0	6.5	.0012	.005	.0244	...do	..do ...	16.0	Sand, cotton, wood, euplotes.
159	Wood, Grenada, Miss.: 28 feet deep, with 2 feet water; 200 yards from cemetery and on 40 feet lower level; clear and colorless.	3.5	1.0	.000	.003	.0830	...do	..do ...	1.4	Sand, a little vegetable *débris*, rotifers, zoospores, and chœtophora.
160	Dr. Saunders, Grenada, Miss.: 34 feet deep, with 2½ feet water; no privies near; clear and colorless.	12.0	2.0	.001	.005	.0879	...do	..do ...	5.4	Cotton and sand.
161	George Lake, Grenada, Miss.: 32 feet deep, with 2 feet water; surface privy 50 feet distant; clear and colorless.	13.0	3.0	.000	.005	.0146	...do	..do ...	.8	Cotton entangling woody tissue and mineral matter.
162	Lee, Grenada, Miss.: 21 feet deep, with 2 feet water; no privies or stables; clear and colorless.	20.0	2.5	.000	.005	.0146	...do	..do ...	4.8	Mineral and woody fragments and a few infusoria.
163	Walthall House, Grenada, Miss.: 24 feet deep, with 3 feet water; house was fever-stricken in epidemic of 1878, and was unoccupied up to time of analysis, October, 1879; clear and colorless.	36.0	2.5	.0012	.007	.1758	...do	..do ...	16.2	Mineral particles, fragments of wood, butterfly scales, cotton fibers, and a few infusoria.
164	Payne's Place, Elliott, Miss.: 50 feet deep, with 8 feet water; stables, &c., 75 yards distant; clear and colorless.	12.0	2.5	.000	.003	.0195	.. do	..do ...	.6	Traces of mineral matter and vegetable decay.
165	Green's Chapel, Elliott, Miss.: 50 feet deep, with 3 feet water; no stables or privies; clear and colorless.	12.0	4.0	.001	.005	.1905	...do	..do ...	1.6	Mineral grains, vegetable fragments, and a few infusoria.
166	Austin, Elliott, Miss.: 28 feet deep, with 6 feet of water; stables, &c., 75 yards distant; clear and colorless.	34.0	4.0	.002	.005	.1612	...do	..do ...	11.4	Cotton and sand.
167	Landress, Duckhill, Miss.: 25 feet deep, with 7 feet of water; 75 feet to stables on lower level; clouded.	10.0	1.0	.001	.003	.0587	...do	..do ...	4.0	Clay particles.
168	Butt, Duckhill, Miss.: 22 feet deep and with 15 feet of water; 50 yards from stables, &c.; sulphuretted taste when not used much; dark and clouded.	10.0	1.0	.001	.006	.0781	.. do	..do ...	.7	Clay, filamentous algæ and infusoria.
169	Dr. Trotter, Duckhill, Miss.: 20 feet deep, with 8 feet water; 50 yards from stables; dark and clouded.	11.0	1.5	.002	.004	.0028	...do	..do .	.5	

WELL-WATERS—Continued.

Number of analysis.	Sample.	Total solids.	Loss on ignition.	Free ammonia.	Organic ammonia.	Oxygen required for organic matter.	Nitrous acid.	Nitric acid.	Chlorine.	Microscopic appearances.
170	Campbell, Grenada, Miss.: 30 feet deep, with 3 feet of water; privy 50 yards distant; clear and colorless.	12.0	1.5	.000	.002	.0244	...do....	..do...	5.6	Mineral matter, filamentous algæ, infusoria.
171	Dancy, Holly Springs, Miss.: 18 feet deep, with 3 feet of water; 80 feet from privy; clear and colorless.	20.0	3.0	.000	.003	.0732	...do....	..do...	.8	Cotton, wood, and a few infusoria.
172	Female College, Holly Springs, Miss.: 32 feet deep, with 3 feet water; no stables; clear and colorless.	7.0	1.0	.001	.004	.1172	...do....	..do...	1.2	Sand.
173	Calhoun, Holly Springs, Miss.: 30 feet deep, with 6 feet water; 30 feet from livery stable; clear and colorless.	41.0	7.5	.000	.004	.0586	...do....	..do...	5.6	Sand, cotton, and woody fragments.
174	Manning, Holly Springs, Miss.: 26 feet deep, with 5 feet of water; stables and privy 100 feet distant; clear and colorless.	13.0	2.5	.000	.005	.1807	...do....	..do...	1.0	
175	Craig, Holly Springs, Miss.: 20 feet deep, with 3½ feet of water; clear and colorless.	11.0	4.5	.001	.005	.0488	...do....	..do...	.6	Mineral particles, wood, and a few infusoria.
176	West, Holly Springs, Miss.: 15 feet deep, with 3 feet of water; 40 feet from surface privy; clear and colorless.	5.5	3.0	.0012	.007	.0684	...do....	..do...	.6	
177	Buchanan, Holly Springs, Miss.: 24 feet deep, with 5 feet of water; no stables, &c.; clear and colorless.	1.5	0.5	.000	.001	.0097	...do....	..do...	.4	Sandy particles.
178	Sevier, Brownsville, Tenn.: 15 feet deep, with 4 feet of water; 50 yards from surface privy; clear and colorless.	37.5	2.0	.001	.006	.0434	...do....	..do...	12.0	Sand, wood, and a few infusoria.
179	Hernando and Clay streets, Memphis: 90 feet from vaults; well deep and bricked; water slightly clouded.	44.0	14.0	.002	.003	.0340	...do....	.022	2.0	Sand, clay, and a few infusoria.
180	Barnes, Waldron avenue, Memphis: 42 feet deep with 10 feet of water; 100 feet from shallow vault; situated outside limits of city; clear and colorless.	32.0	13.0	.0006	.003	.0048	...do....	.022	1.8	Mineral grains and diatoms.
181	D. Bond, Brownsville, Tenn.: 75 yards from surface privy and stables; clouded.	12.0	2.0	.002	.004	.1215	...do....	None.	2.2	Cotton, clay, some decaying vegetation, and infusoria.
182	344 Madison street, Memphis: 30 feet deep, with 25 feet of water; vault 21 feet distant, 15 feet deep.	40.0	10.0	.0004	.003	.0796	...do....	...do ...	2.2	Sand and a few infusoria.
183	Wilson, Brandon, Miss.: 30 feet deep, with 4 feet of water; stables 50 feet distant; faintly clouded.	14.0	2.5	.001	.013	.0635	None.	None.	3.4	Mineral particles, decaying wood, and filamentous algæ.
184	Clinton, Brownsville, Tenn.: 32 feet deep, with 3 feet of water; 90 feet from stable; clear and colorless.	26.0	2.5	.0012	.011	.4982	...do....	..do...	6.6	Many infusoria and but little decaying matter.
185	42 Winchester street, Memphis: Nearest vaults 37 feet distant; clear and colorless.	238.0	112.5	.001	.005	.0678	...do....	18.338	36.0	Sand and a few fragments of wood.
186	30 Main street, Memphis: Well very deep, 50 feet from vaults; clear and colorless.	82.0	29.0	.0016	.005	.0720	...do....	.022	5.2	Chiefly mineral grains.

187	191 Jefferson street, Memphis: 30 feet deep, with 15 feet of water; vault 140 feet distant; clear and colorless.	98.0	42.0	.0006	.005	.1102	...do....	3.993	9.8	Mineral grains and a few infusoria.
188	Mr. McLauren, Brandon, Miss.: 18 feet deep; 3 feet of water; clear and colorless.	182.0	25.0	.0012	.018	.1710	.. do....	None.	18.8	
189	Doak, Grenada, Miss.: 22 feet deep and 3 feet of water; much clouded.	41.0	10.0	.016	.035	.7230	...do....	..do...	8.8	Mineral particles, cotton, decaying vegetation, filamentous algæ, and many infusoria.
190	McNamara, Elliott, Miss.: 30 feet deep, with 3 feet of water; surface privy 40 yards distant; dark and clouded.	6.0	2.5	.001	.016	.3370	.. do....	..do...	1.9	
191	Dougherty, Holly Springs, Miss.: 20 feet deep, 5 feet of water; popularly said to be best water in the town; clear and colorless.	66.0	30.0	.005	.024	.2100	...do....	..do...	3.2	
192	Waites, Holly Springs, Miss.: 19 feet deep, with 5 feet of water; surface privies 100 feet distant; clear and colorless.	33.0	7.5	.002	.048	.2491	...do....	..do...	3.8	Vegetable decay, paramecia, and anguillula.
193	Davis, Holly Springs, Miss.: 25 feet deep, with 8 feet of water; 300 feet from cemetery, but on 10 feet higher level.	13.0	5.5	.001	.041	.4738	...do....	..do...	1.2	
194	Heywood, Brownsville, Tenn.: 62 feet deep, 2½ feet of water; 65 feet from surface privy; water with sulphuretted odor and clouded.	70.0	38.0	.001	.058	.4885	...do....	..do...	4.8	Vegetable decay and vorticella.
195	Adams, Holly Springs, Miss.: 40 feet deep, 3 feet of water; 70 feet from surface privy; slightly clouded.	9.0	2.0	.002	.007	.0432	...do....	.203	1.4	
196	Strictland, Holly Springs, Miss.: 30 feet deep, 8 feet of water; no stables, &c.; clear and colorless.	37.0	19.0	.000	.005	.0195	...do....	.369	7.2	
197	Mosby, Holly Springs, Miss.: 20 feet deep, 3 feet of water; 100 feet from surface privy; clear and colorless.	23.0	3.0	.002	.005	.1172	...do....	.270	7.0	Mineral grains and a few infusoria.
198	Sims, Holly Springs, Miss.: clear and colorless.........	10.0	4.0	.001	.004	.0783	...do....	.160	1.4	
199	429 Pontotoc street, Memphis: 40 feet deep, with 10 feet of water; clear and colorless.	32.0	14.0	.002	.007	.0429	...do....	.284	1.8	Sand, clay, woody tissues, cotton, and infusoria.
200	State and Franklin streets, Mobile, Ala.: 65 feet deep; clear and colorless.	16.0	8.0	.0006	.007	.0167	...do....	4.402	1.8	
201	St. Michael Street, Mobile, Ala.: 60 feet deep; clear and colorless.	11.0	6.0	.0006	.004	.0277	...do....	.734	2.0	Mineral matter and zoospores.
202	Davis avenue, Mobile, Ala.: 50 feet deep; 40 feet from vault, 30 feet from stables; clear and colorless.	11.0	8.0	.0006	.004	.0277	...do....	.440	2.4	
203	Featherstone, Holly Springs, Miss.: 33 feet deep, with 2½ feet of water; 60 feet from stables and privies; clear and colorless.	14.0	4.0	.001	.011	.0869	...do....	.387	3.4	Sandy particles, decayed leaves, and many infusoria.
204	Jail, Grenada, Miss.: 24 feet deep, with 3 feet of water; clouded.	34.0	4.0	.0012	.013	.0537	Trace.	....	11.0	woody tissue, clay, and some infusoria.
205	Kearney, Elliott, Miss.: 20 feet deep, with 5 feet of water; no stables or privies; clear and colorless.	30.0	4.5	.001	.005	.1025	.057	....	7.8	Sandy particles.
206	Berson, Brownsville, Tenn.: 31 feet deep, with 4 feet of water; vault 40 feet distant; faintly clouded.	32.0	5.5	.0012	.010	.1221	.036	....	6.4	Decaying leaves and a few infusoria.
207	160 St. Martin's street, Memphis: 34 feet deep, 14 feet of water; nearest privy 95 feet distant; clear and colorless.	38.5	17.0	.002	.003	.0245	Trace.	....	1.8	Decaying vegetation and vast numbers of infusoria and vorticels.
208	McCord, Grenada, Miss.: 24 feet deep, with 3 feet of water; stable 36 feet distant, surface privy 40 feet; faintly clouded.	52.0	10.0	.010	.012	.0120	None.	....	13.6	Cotton fibers, vegetable decay, and infusoria.

WELL-WATERS—Continued.

Number of analysis.	Sample.	Total solids.	Loss on ignition.	Free ammonia.	Organic ammonia.	Oxygen required for organic matter.	Nitrous acid.	Nitric acid.	Chlorine.	Microscopic appearances.
209	Wolf, Grenada, Miss.: 13½ feet deep, 20 inches of water; clear and colorless.	16.0	3.5	.012	.018	.2345	.0210	....	6.0	A mass of organic matter and organisms, paramecia, anguillula, rotifera, filamentous growths, human hair, and epethelium.
210	24 Front street, Memphis: Well very deep; 14½ feet from vault on east; 21 feet from vault on west; clear and colorless.	91.0	33.0	.007	.005	.0486	None.	.095	14.0	A few mineral grains.
211	Jackson, Miss.: 31 feet deep; stable 6 feet distant; clear and colorless.	90.0	10.0	.003	.032	.2051	Trace.	....	7.8	Many cotton fibers, entangling diatoms, kerona, and paramecia.
212	Exchange Hotel, Brownsville, Tenn.: 32 feet deep, with 3 feet water; 90 feet from vault and 150 from stable; clear and colorless.	53.5	16.0	.004	.014	.0224	.0115	4.130	12.2	Much decayed wood and other vegetable matters, with paramecia in large numbers.
213	Galt House, Brownsville, Tenn.: 26 feet deep, with 3½ feet water; 30 feet from vault; clear and colorless.	45.0	22.0	.001	.004	.0147	.0463	9.453	14.0	Mineral grains, cotton fibers, anguillula and paramecia.
214	86 Madison street, Memphis: 38½ feet deep; vault 83 feet distant; 60 feet deep; clear and colorless.	162.0	67.0	.0024	.003	.0368	Trace.	13.338	27.0	A few mineral particles.
215	Rather, Holly Springs, Miss.: 24 feet deep and 3 feet water; stable 15 feet distant; clear and colorless.	32.0	10.5	.002	.009	.2735	None.	.398	4.4	Much organic *débris*, bacteria, filamentous growths, anguillula.
216	Levy, Holly Springs, Miss.: 20 feet deep, with 3 feet water; 40 feet from vault, and 30 from stables; clear and colorless.	64.0	27.0	.001	.013	.0928	...do	1.689	9.2	Organic decay, paramecia, anguillula, and vorticels.
217	Meyers, Holly Springs, Miss.: 20 feet deep, 3 feet water; 200 yards from cemetery; clouded.	24.0	7.0	.002	.019	.1465	...do	.523	5.8	Vegetable and mineral matter, rotifers, anguillula, and paramecia.
218	Moore, Brownsville, Tenn.: 25 feet deep, with 4 feet water; 150 feet from stables and vaults; clear and colorless.	93.0	33.0	.002	.014	.0439	...do	7.146	21.4	Decayed vegetation, and vast numbers of infusoria and confervoid filaments.
219	Cedar Well, Brownsville, Tenn.: 35 feet deep, 4 feet water; 30 yards from vault, 75 from stables; slightly clouded.	33.0	13.0	.001	.016	.0147	...do	3.100	4.6	Amphileptus and anguillula, and much vegetable decay.
220	Klyce, Brownsville, Tenn.: 22 feet deep, 4½ feet water; 100 yards from stables and privy; slightly clouded.	15.5	7.0	.002	.034	.0344	...do	2.034	2.2	Decaying vegetation; no infusoria; anguillula in large numbers.
221	Bond, Brownsville, Tenn.: 32 feet deep, with 3 feet water; 50 yards from privy and stables; clear and colorless.	38.0	8.0	.020	.007	.0440	...do	1.505	5.8	Much vegetable matter, infusoria, bacilli, anguillula.
222	27 Main street, Memphis: Well very deep; 37 feet from deep vault; clear and colorless.	217.0	78.0	.005	.056	.1020	...do	30.481	30.4	Very little decaying matter, but vast numbers of infusoria, vorticella and cercomonas.

223	59½ Front street, Memphis: Well very deep; 10 feet from vault; clear and colorless.	146.0	70.0	.005	.010	.0680	...do....	3.342	24.0	As last, but without the vorticels.
224	Third and Mill streets, Memphis: Well deep; 35 feet from full vault; clear and colorless.	115.0	45.5	.011	.018	.3797	...do....	3.294	13.0	Kerona and paramecia; little vegetable decay.
225	371 Vance street, Memphis: No particulars; clear and colorless.	103.0	47.0	.0008	.018	.0980	do....	3.993	10.0	Sand, cotton, vegetable *débris* and bacteria.
226	38 Drew street, Memphis: 26 feet deep, with 14 feet water; 15 feet from nearest vault, 30 feet deep and full; vault on higher level; faintly clouded.	110.0	53.0	.023	.033	.5944	...do...	7.711	14.4	Mineral particles entangled in cotton with various organic matters, rotifers, vorticels, and anguillula.
227	20 Jackson, street, Memphis: 64 feet deep, with 30 feet of water; nearest vault 41 feet distant, 40 feet deep, and full; vault on higher level; clear and colorless.	151.0	68.0	.003	.038	.3736	...do....	6.437	28.0	
228	116 Front street, Memphis: 60 feet deep, with 12 feet water; 6 feet distant from vault; clear and colorless.	166.0	73.5	.0006	.030	.2450	...do....	17.154	25.8	
229	178 Poplar street, Memphis: 40 feet deep; nearest privy 53 feet distant, 25 feet deep, and filled to 3 feet from surface; faintly clouded.	58.0	24.0	.009	.048	.7105	do....	3.185	9.6	Much clay in sediment, amphileptus, and anguillula.
230	Opposite 162 Saint Martin street, Memphis: 20 feet deep, with 4 feet water; vault 30 feet distant, 7 feet deep, with 5 feet of contents; vault on higher level; slightly clouded.	112.0	33.0	.003	.009	.2878	...do....	10.883	11.0	Clay, vegetable decay, anguillula.
.31	Valance and Tchoupitoulas streets, New Orleans: Depth 18 feet; used when cistern water-supply runs short; 40 feet from privy; dark in color and clouded.	66.5	9.0	.143	.082	1.2099	...do....	.096	7.7	Sand, much decaying vegetation, zoospores, oscillatorians, paramecia.
232	158 Chestnut street, New Orleans: 10 feet deep, with 7 feet of water; dark and clouded.	110.0	12.0	.020	.030	.3940	...do....	.726	30.6	Sand, woody tissue, kerona, rotifera, and arachnidians.
233	Hampson street, New Orleans: 18 feet deep; 20 feet from stable, 30 from privy; dark and clouded.	69.0	16.0	.026	.041	.4717	...do....	.096	16.0	Swarming with paramecia; vegetable *débris*.
234	Burdette street, New Orleans: 18 feet deep; 20 feet from vault and stables; dark and clouded.	126.0	40.0	.292	.044	.7881	...do....	.096	22.4	Large amœboid masses; lacrymaria and cercomonas, much organic decay.
235	Lawrence and Bloodgood streets, Mobile, Ala.: 20 feet deep; 30 feet from vault; clouded.	97.0	44.0	.004	.012	.1054	...do...	23.333	14.6	Vegetable matter; naguillula; no infusoria.
236	Lawrence and Eslava street, Mobile, Ala.: 18 feet deep; 35 feet from vault; clear and colorless.	60.0	10.0	.002	.010	.0943	None.	4.402	13.0	Sediment small; anguillula.
237	Conception street, Mobile, Ala.: 25 feet deep; 50 feet from vault; clear and colorless.	6.0	3.5	.011	.003	.0167	... do....	.370	1.2	Clay simply.
238	Conception street (bored well), Mobile, Ala.: 30 feet from vault; clear and colorless.	21.0	6.0	.044	.009	.0277	... do....	2.935	3.0	Mineral matter; no active life.
239	Broad street, Mobile, Ala.: 20 feet deep; 20 feet from stables; 30 from vault; clear and colorless.	118.0	19.0	.0006	.017	.0943	... do....	9.180	39.0	Mineral particles, confervoid filaments, zoospores, and recent woody tissue.

SPRING-WATER.

240	**Parnell's Spring, Brandon, Miss.: Well protected; no sinks or stable near; clear and colorless.**	10.0	2.0	.001	.004	.0195	... do....	None.	1.15	Sand.
241	**Youst's Spring, Brandon, Miss.: No privies or stable near; but several stagnant pools of surface water which in wet weather might contaminate the spring; clear and colorless.**	17.0	3.0	.001	.010	.0977	... do....	.. do...	.8	

SPRING-WATER—Continued.

Number of analysis.	Sample.	Total solids.	Loss on ignition.	Free ammonia.	Organic ammonia.	Oxygen required for organic matter.	Nitrous acid.	Nitric acid.	Chlorine.	Microscopic appearances.
242	Public spring, Holly Springs, Miss.: Clear and colorless.	31.0	4.0	.002	.007	.0635	... do....	.. do...	3.8	Sand, decaying vegetation, and infusoria.
243	Laundry Spring, Ward 1, Holly Springs, Miss.: Clear and colorless.	7.0	5.0	.064	.009	.0684	... do....	.. do...	.6	Sand, decaying vegetation, and many infusoria.
244	Memphis Spring, sent to New Orleans by Dr. F. W. Reilly for examination: Clear and colorless.	80.0	15.0	.005	.005	.1332	.7243	.. do...	24.8	
245	Hydrant water, Health Office, Mobile, Ala.: Clear; faint straw-color.	6.0	3.5	.004	.010	.3552	None.	.110	.275	Sand, confervdoi filaments, and zoospores.
246	Hydrant water, Market Exchange, Mobile, Ala.: Clear; faint straw-color.	6.0	3.5	.004	.010	.3829	... do....	.110	.275	

RIVER-WATER.

Number of analysis.	Sample.	Total solids.	Loss on ignition.	Free ammonia.	Organic ammonia.	Oxygen required for organic matter.	Nitrous acid.	Nitric acid.	Chlorine.	Microscopic appearances.
247	Wolf River water obtained at mouth of river from surface after heavy rains November 18, 1879: Water opaque from fine particles of reddish clay.	44.0	6.5	.022	.071	.5783	... do....	None.	.45	Clay, sand, infusoria, and vorticela.
248	Mississippi River, New Orleans, March 10, 1880, high water: Opaque from clay and sand.	29.0	8.0	.016	.050	.4566	... do....	.. do...	.30	
249	Wolf River water as supplied to Memphis November 12, 1879: Opaque from clay.	49.7	6.5	.001	.037	.3010	... do....	.. do...	.20	
250	Wolf River water, Memphis supply, December 15, 1879, when Mississippi River was over 10 feet above low water, causing stagnation in the mouth of Wolf River: Opaque from clay; sedimented for two days before examination.	30.0	5.0	.001	.085	.5635	... do....	.. do...	.20	Sand, clay, and an occasional animalcule.
251	Mississippi River water, trapped December 15, 1879, above the mouth of Wolf River, and 25 feet below the surface: Opaque from clay and sand; sedimented for two days before examination.	20.0	6.0	.002	.086	.4655	... do....	.. do...	.35	
252	Mississippi water, Memphis, November 18, 1879, above mouth of Wolf Liver, midstream, and at a depth of 30 feet from surface; depth of river 60 feet; stage of water 1 foot 7 inches, and rising 4 inches in twenty-four hours: Water heavily clouded.	28.0	7.0	.003	.017	.3207	... do....	.. do...	1.00	

253	Mississippi water, above Memphis, in center of channel and 30 feet below the surface; stage of water 7.5 feet and rising 3 inches in twenty-four hours, December 2, 1879: Very turbid; sedimented for three days before examination.	20.0	4.5	.001	.013	.3736	... do....	.. do...	.50	
254	Wolf River water, midstream at Raleigh December 2, 1879; river at medium stage; last rain on 28th November, 1879: Very turbid; sedimented for three days before examination.	32.5	6.5	.003	.020	.4471	... do....	.. do...	.15	
255	Wolf River water from in front of influx pipe of Memphis water works, from surface, medium current and stage of water: Very turbid; sedimented for three days before examination.	36.5	6.5	.001	.028	.4593	... do....	.. do...	.15	
256	Elmwood Creek, Memphis: Turbid from clay particles.	23.0	3.5	.001	.033	.5297	... do....	.. do ..	.15	Clay and vorticella.
257	Wolf River water; Peabody Hotel cisterns; water stored in August, when river was low and almost free from turbidity; drawn and examined November, 1879: clear and colorless	28.5	4.5	.001	.004	.0437	... do....	.. do...	.45	Clay only.
258	Wolf River water; Gastin's Hotel cisterns; examined November, 1879: Clear and colorless.	12.5	2.5	.0004	.003	.1069	... do....	.. do...	.20	Sand, clay, and zoospores.
259	Wolf River water; cistern 177 Union street, stored October; drawn and examined six weeks thereafter: Clear and colorless.	12.5	3.0	.0006	.008	.1701	... do....	.. do...	.30	
260	Wolf River water, filtered through animal charcoal, November, 1879: Clear and colorless.	26.0	7.0	.0004	.0015	.0195	... do....	.. do...	.20	Some fine particles of clay.
261	Mississippi River, filtered March, 1880; wood charcoal: Clear and colorless.	27.5	3.0	.078	.004	.0000	... do....	.. do...	.625	Nil.
262	Mississippi water, filtered through English sandstone, at Jesuits' college, New Orleans: Clear and colorless.	21.0	3.0	.005	.027	.1776	... do....	.145	.50	Protococcus, zoospores, vorticella, and mineral grains.
263	Mississippi water, filtered through sandstone, New Orleans, March, 1880.	21.0	7.0	.000	.005	.1387	... do....	None.	.30	Nil.
264	Louisiana ice: Clear and colorless.	2.0	1.0	.033	.011	.0444	... do....	.. do...		Woody tissue from saw dust.
265	Boston ice: Clear and colorless	.75	.25	.010	.012	.0388	... do....	.. do...		
266	Swamp-water, New Orleans: Clear and colorless.	121.0	28.0	.048	.090	1.3450	Trace.	.. do...	4.5	Protococcus cells, bacteria, amœba, cercomonas, many active and energetic vorticella.
267	Sewage, New Orleans.	82.5	31.5	.240	.120	1.1544	... do....	.. do...	25.0	Clay, bacteria, rotifers, and some large annelids.
268	Potomac water, Washington supply, May 30, 1880: Clear and colorless.	13.0	1.0	.000	.012	.1843	None.	.. do...	.20	Clay and decaying vegetation; entomostraca, rotifers and anguillula.
269	Water from well at Ship Island, near Quarantine Station; six weeks in bottles before analysis: Clear and colorless.	14.0	7.0	.0003	.011	.3783	...do	.. do...	1.55	Sand, clay, much woody tissue, and a few specimens of euglena.

NOTES TO PRECEDING TABLE.

Nos 1 and 3 show the high ammonia and albuminoid figures obtained at the commencement of a rainfall. Nos. 2 and 4 manifest the purer character of the water towards the end of the fall, although the free ammonia in No. 4 is much increased on account of electric conditions. The microscope gives the general constitution of the atmospheric impurities brought down by the rainfall. Since No. 1 is the average water of four hours of rainfall, and No. 3 that of three hours of fall, it is plain that to exclude impure water from a cistern, the use of the cut-off must be continued long after the grosser impurities from the atmosphere and roof have been washed away. In No. 5 the ammonia is high, probably from products of combustion deposited on the roof. These analyses were made to show the character of the water which was entering the cisterns for storage.

Nos. 6 to 16 are samples of the purest waters found in tanks. The large ammonia figures in No. 6, 7, 9, and 11 are from recent rainfall. The permanganate result is higher in No. 6, the sample being from a shingle roof, than in the others, which are from slate roofs. The nitric acid in No. 6 is identical with that in No. 5, the estimation in both cases having been made to ascertain the normal figure. The chlorine of No. 7 is higher than usually occurs with good water. The microscopic characters are satisfactory in all, the zoospores which appear in Nos. 12 to 16 having, so far as ascertained, no sinister meaning. They are present in the rainfall No. 1.

After the distillation of the albuminoid ammonia from No. 16, the contents of the retort were permitted to stand for twenty-four hours, when a further distillate was obtained which contained no ammonia. (See also No, 244.) No. 16 was brought in by the sanitary inspector, as a sample of the good cistern water in his district. Compare its results with No. 44. In No. 17, the rotifers are noticeable. They seldom occur in water which gives such good results by the chemical processes. There are probably foul accumulations at the bottom of the cistern, which, under the influence of increased temperature, will give a less satisfactory drinking water. Nos. 18 and 19 are good waters, obtained by trapping the sedimentary matters in an iron tank and permitting the cisterns to fill by overflow from it. The sandstone filter in No. 19 exercises little or no influence on the purification of the water. It was found to be a simple diaphragm through which the water passed with the mechanical separation of suspended particles, but with no exposure to oxidizing influences. Compare Analyses 262 and 263.

Nos. 20 to 33 must be considered fair specimens of cistern water. They will probably become tainted during the summer season. Nos. 20 and 23 bumped viciously during the albuminoid distillation.

The large oxygen figures corresponding with the shingle roof are seen in Nos. 27 and 29, where the free ammonia also is high. The origin of the ammonia in No. 25 is unknown. The cyclops, hydrachna, and ciliated infusoria in Nos. 20 to 27 are so often met with in waters which universal experience shows to be wholesome, that their presence indicates only a larger amount of organic matter in the waters than in those which precede them on the list. The albuminoid figure in No. 27 is high on account of the presence of these ciliated animalcules. The sediment was stirred from the bottom of the cistern before collecting the water, under the mistaken idea that the analyst required a goodly proportion of it in the sample bottle. The rotifers in Nos. 28, 29, and 32 are a higher phase of animal development, and lead the way to the more impure waters which follow.

Nos. 29, 30, and 31 were furnished by a gentleman much interested in the methods for insuring purity in cistern waters, and were intended to illustrate the efficiency of such methods; No. 29 to show the character of the water from a shingle roof, collected as is customary with no effort to exclude roof-washing, and stored in a cistern which had not been cleaned in four years; Nos. 30 and 31 to show the same rainfall as shed from a slate roof with a cut-off guarding the entrance to the cisterns. Unfortunately, the latter samples were contaminated by rotten and alcoholic corks in the containing vessels, which gave rise to the anomalous microscopic appearances, and deprived the experiments of comparative value.

The ammoniacal contamination in Nos. 34 and 35 is sufficiently explained by their proximity to the "works." The albuminoid ammonia in the latter was not determined.

Nos. 36 to 40 are not such waters as should be contained in the cisterns of public institutions.

Nos. 40 to 46 are undoubtedly bad waters, the rotifers, vorticells, amœboids, &c., showing the rankness of the impurity, and rendering chemical investigation unnecessary. No. 44 was brought by the sanitary inspector as an illustration of the bad cistern water in his district. No. 45 was sent as a sample of suspicious water in connection with malarial remittents occurring among the persons making use of it. No. 46 is from a well-paved and non-malarious part of the city of New Orleans. It was furnished by Dr. C. B. White, medical director of the Citizens' Auxiliary Sanitary Associ-

ation, in order that lead, if present, might be detected, as the persons using the water had been affected with many anomalous symptoms. No lead was found, but the impurity of the sample was such that the analyst believed himself dealing with swamp water furnished for the purpose of testing his results. During the progress of the analysis a severe case of remittent fever developed in the house supplied with the water. Suspicion was aroused in the minds of the people, and the cistern was disused. When the analyst reported the water as the essence of malarial remittent, the occurrence of this fever in the house was made known to him. The albuminoid ammonia in Nos. 42, 45, and 46 distilled in quantities which diminished 50 per cent. in successive measures of 50 c. c. In the others the evolution was more rapid.

The principal points which have to be considered in connection with the rain-water supplies furnished by raised cypress-wood tanks are:

1st. The impurity of the rain-water at the commencement of the fall, as shown by analyses Nos. 1 and 2, and even after the fall has continued for some time, as in the sample No. 3.

2d. The additional impurities which are washed from the roof, especially by the first portions of a rain-shower. This is illustrated by the character of the dust which settles from the dry atmosphere of a city. A specimen of this dust was obtained from some open upper rooms of a public building in New Orleans. It gave 17.2 per cent. of moisture, 34 of matter destroyed by heat, and 48.8 of mineral residue. Of the dry dust 11 per cent. was dissolved by maceration in water for twenty-four hours. Six of these 11 parts were inorganic salts, and 5 were organic matter, which manifested its quality by requiring per 100 parts 668 parts of oxygen for its destruction, and yielding per 100 parts 6 parts of albuminoid ammonia. The residue, insoluble in water, contained nitrogen enough to furnish .5 per cent. of organic ammonia, indicating the presence in it of organic matters which prolonged maceration and fermentative changes might reduce to a soluble condition.

3d. The accumulation of this roof-washed matter in the bottom of the cistern and the putrefaction or fermentation which is liable to be set up in it during warm weather. The rate of accumulation was determined from observations in fifteen cisterns to be about one inch per year. The sediment when dried consisted of 73.4 per cent. of mineral matter and 26.6 per cent. of matter destroyed by heat. One hundred parts yielded .54 part of organic ammonia.

4th. The diffusion in the stored waters of the mobile upper layers of the accumulated sediment caused by the intrusion of fresh rainfalls. The suspended matters in a cistern water thus disturbed are chiefly organic, the weightier minerals refusing to rise. Hence the water is rendered impure for several days after each fall by matters which ought not to have been admitted into the cistern, or which ought not to have been disturbed after their admission and original subsidence.

5th. The insufficiency of the purification effected in the cleanest and best of these tanks, as compared with that which is accomplished in underground brick cisterns. The exclusion of light and the lowered temperature in the latter have more to do with the purification than the material of the cistern. Water drawn from brick cisterns which were not sunk was found at Fort Preble, Me., during the summer season to have the same characters as that from the cypress-wood tanks of New Orleans. Extreme cases are of course excluded where rotting wood contaminates the water.

To obtain as pure a water as can be furnished by this method of rain-storage, the first of all rainfalls should be rejected by means of a cut-off until not only the roof but the atmosphere is thoroughly washed; the fresh inflow should be conducted into the cistern in such a manner as to prevent disturbance of the contained water; and the cistern should be clean, covered, shaded, and well ventilated. The cut-off with ordinary care and attention will prevent accumulation of sediment from the roof, but it is doubtful if even the most careful persons will continue its use long enough to insure a pure water from the atmosphere. The rain-supply is so uncertain that when it falls, too much of it must not be cast aside, lest the cistern remain unfilled. People with two reservoirs can run the waste water into one for domestic uses and collect a pure rain-water for drinking supplies in the other; but the double cistern is not common. To store the rainfall in a single cistern and at the same time obtain a water for drinking which shall be above suspicion is impracticable. The cut-off may and should be used to wash the roof and preserve the cistern from excess of sediment, but its use so restricted will not furnish a reliable water. The raised tanks protect New Orleans from the ravages of typhoid fever, but the specific poison of malarial fever may be present in the atmospheric sewage which is carried into them. If this possibility cannot be prevented by the continued use of the cut-off, there is no resource but filtration. Purification in the household of the small store of water required as a drinking supply may be readily and cheaply effected. The household filter can be made by any tinsmith. It consists of a modified funnel, the body of which rests on a tin bucket or receiver, while the tube projects downward to the bottom of the said bucket. The lower end of the tube is tied over with some filtering cloth. Three-fourths of its length is filled with granulated animal charcoal and the upper fourth

with sand. The upper end of the tube projects about half an inch into the body of the funnel to permit of tying a filtering cloth over the top of the sand. The angle between this projection and the sloping sides of the funnel serves to trap solid matters. To clean this filter the filtering cloth guarding the top of the tube has to be removed, washed, and replaced. At longer intervals, when the filter shows signs of clogging, half an inch of the upper layer of sand may be removed and replaced by fresh material. At yet longer periods the whole of the contents of the tube may be dumped out and renewed. Earthenware is more durable than tin, and would preserve the water cooler during the warm months. A sample of cistern water containing .016 part of organic ammonia, when purified by passing through wood charcoal in a filter as above described, gave .007 part. But animal charcoal should be used, in which case such a water as that of this cistern would be reduced almost to organic purity.

The albuminoid ammonia process affords the best insight into the character of rain-water in raised tanks, the results being uniformly in accordance with the microscopic evidence. When the albuminoid amounts are deprived of their fractional value by erasing the decimal points and the ciphers which follow them, the figures which are obtained constitute a useful scale of relative impurity. By means of them an appreciation of the character of different waters can be conveyed to those who, while interested in the waters in question, are ignorant of the methods of analysis and of the value to be attached to the determination of the organic ammonia. When it is known that 0 expresses an organically pure water or one containing .000 part, 3 or 4 (.003 or .004 part) a pure spring water, 10 (.010 part) a good rain water, 20 (.020 part) a dangerous water, and 90 (.090 part) water from the swamps, the sanitary position of a cistern water, with an impurity figure of 12, 22, or 39, &c., can be communicated with precision.

Nos. 47 to 75 are samples of good water from sound cisterns. Calcic carbonate was found in the residue of many, as in Nos. 52, 54, 62, 63, and others, and was believed to indicate leakage from the soil, but when found in Nos. 64, 65, and 66, in comparatively large quantity without a corresponding increase in the chlorine, the lime was referred to its proper source—the lining of the cistern. Excess of total solids was dependent on the lime carbonate except in Nos. 59, 62, 68, 73, and 74, where clay particles were the cause. The chlorine is large in No. 73 and would indicate leakage but that the microscope shows Wolf River clay to be present, and suggests that the chlorine may remain from river water recently stored in the cistern. The albuminoid figures are under .010 in all these cases. The ammonia is variable, and from the permanganate results nothing could be predicated of these waters as a class. Witness, for instance, the large figures in Nos. 62, 66, and 70. The microscopic characters comprise soot and mineral matters with more or less of decayed vegetation, zoospores, euglena peranema, acomia, and enchelys, with occasionally the cyclops. The chlorine figures show the soundness of the cisterns and the impossibility of sewage contamination in any of the waters. Sometimes, as in Nos. 58 and 59, where the waters were uninviting in appearance from soot or clay discoloration, and the cistern in the latter case at least in such dangerous proximity to vaults, the question of wholesomeness depended entirely on the amount of chlorine found. The free and albuminoid ammonias and the permanganate results might have been obtained from a water contaminated by sewage, but in that event the chlorine would have been higher than .05 and .15 parts. The traces of nitric and nitrous acids with the free ammonia and the proximity of the cistern to the privy vault suggest sewage in the case of No. 75. With any increase in the chlorine this water would have to be considered dangerous. The albuminoids of the water have undergone oxidation while stored.

Nos. 76 to 85 are from sound cisterns, as evidenced by the quantity of chlorine; but although the albuminoids are under .010, the amount of vegetable decay and profusion of microscopic life in the sediment, as in Nos. 77 and 78, with the rotifers of Nos. 76, 79, 80, 81, and 83, the vorticels of No. 82, and the anguillula of No. 84 indicate the waters as less desirable than those which precede them. No. 84 is chemically an excellent water, but as anguillula is usually an inhabitant of foul cisterns, its presence in connection with the small increase in nitrates was made the basis of a suspicion against the water. This cistern furnished the supply of one of the public schools, and as such supplies should be above suspicion, an adverse report was rendered, which resulted in orders for the purification and disuse of the neighboring vaults and the cleaning and relining of the cistern. In No. 85, the cistern water of another of the public schools, the comparatively large loss on ignition called for a determination of the nitrates. Although the chemical results do not throw doubt on the water, the lively microscopic field in connection with a small portion of decaying solids and the nitric acid increase, suggested the cleaning out of the cistern as a means of precaution.

In No. 86 an examination of the chemical results would indicate sewage pollution as probable. The small oxygen and albuminoid figures with the relatively large amount of free ammonia might result from ureal decomposition, especially when accompanied by the chlorine, which is present in this case. Nitrates were determined in this water on account of its suspicious character. An adverse report would have

been rendered, but the excess of chlorine was satisfactorily accounted for. A few months before, at the beginning of the year 1879, the yellow-fever season, some one connected with the institution (Christian Brothers' School) threw common salt into the cistern as an antiseptic or preservative. A consideration of the quantity said to have been introduced, in connection with the subsequent rainfall, the capacity of the cistern, and the chlorine found, corroborated this statement as to the origin of the suspected sewage salt, and sustained the microscopic appearances which until then had stood alone in their favorable testimony.

Nos. 87 to 101 are shown by the chlorine to be samples from sound cisterns, although calcic carbonate was present in them all. No. 91 has a slight excess of chlorine, but the clay particles which accompany it indicate the possibility of Wolf River water having been at one time contained in the cistern.

Nos. 87 to 91 are usable waters, judging from their general appearance and repute and the microscopic characters of their sedimentary matters, although in No. 90 the albuminoid figure is high, probably from a disturbance of the sediment in the cistern as in the case of the raised tank No. 27.

Nos. 92 to 100 are undoubtedly bad waters, basing the opinion on the microscopic appearances and the albuminoid and oxygen figures which testify to a large organic contamination of the same nature (except in No. 100) as that which is present in impure, freshly-fallen rain. Even No. 94, with its large amount of carbonaceous matter, as shown by the permanganate, yields its albuminoid ammonia in the same manner as the rainfall. The successive distillates of No. 100 gave .06, .03, .01 of organic ammonia.

Nos. 95 and 96 have the albuminoids small compared with the others, but in other respects they are similar. But for such cases and those which, like No. 90, have the albuminoids higher in an apparently purer water, the amount of organic ammonia would be the index of the character of rain-water stored in sound cisterns.

Nos. 93 and 94 are from cisterns which were used by a settlement of 100 people, 25 of whom were seized by yellow fever during the epidemic of 1878; mortality, 13.

The owner of the cistern from which No. 97 was obtained was suffering from an attack of malarial hæmaturia, simulating yellow fever, at the time of the examination. The analyst is indebted for the sample and for the privilege of investigating the febrile case to the kindness of Dr. Wirt Johnson, secretary of the Mississippi State board.

The nitrites in Nos. 92, 96, and 100 must have been formed during the storage of the waters, as the cisterns are manifestly impermeable.

Nos. 98 and 99 are condemned, irrespective of their proximity to vaults. They show that a cistern can be made practically impervious, for in them any leakage would be shown by an excess of chlorine.

Three hundred people use the water No. 100.

The large amount of free ammonia in No. 101 indicates sewage or a condition of cistern which interferes with the natural process of purification. The chlorine figure contra-indicates sewage pollution. The microscopic appearances in this water were deceptive. No vegetable decay was discovered. The study of this sediment and of others in connection with it showed that a water containing much organic matter in solution may give no indication of its character under the microscope if it is drawn without disturbing its perfect sedimentation. If, however, there is present in the sample bottle some small particles of decaying vegetation, much organic life will be found around them if the water is impure. (See analyses Nos. 126 and 127.)

In Nos. 102 to 115 the albuminoid figure is below .010. They are samples of good water drawn from leaky cisterns. They do not show the presence of sewage pollution, but they are liable to be contaminated at any moment. Relining would suffice to render them valuable reservoirs, provided there is no collection of filth in their neighborhood; but in No. 109, for instance, where the vault is represented as being only 5 feet distant, no measure less radical than the disuse of the cistern could be considered compatible with sanitary requirements. In this case, the small amount of free ammonia guarantees wholesomeness for the present. In other samples, as Nos. 107 and 114, the absence of free ammonia bespeaks present purity. In No. 111, where the ammonia might be considered suggestive of urea, the microscopic characters free the water from suspicion. In No. 112, also, the microscopic evidence is valuable The cistern from which No. 106 was obtained could hardly be called a rain-water reservoir. It was supplied originally by the rainfall from the roof of a hotel; but the building having been destroyed, the cistern was disused for several years until water was discovered in it by some colored squatters, who resumed its use. The water supply is derived from the soil, like that of a shallow well.

Nos. 108 and 115 have the chlorine quantity no larger than that of some raised tanks, but cistern waters which obtain such chlorine figures from roof washings are usually highly charged with organic impurities. The purity of these specimens appears to indicate that the small increase in the chlorine comes from the soil by leakage. No. 112 was at one time stored with Wolf River water, and preserved the clay in the sediment as a record of the storage. The large loss on ignition in 114 appears to have been moisture chiefly.

Nos. 116 to 119 leak, No. 117 to a small extent, so that it is only by comparing the general character of the water with the chlorine figure, as in Nos. 108 and 115, that the leakage can be established. In a sound cistern .3 part of chlorine would be accompanied by a greater amount of organic impurity than is present in this case. Chemically urea might be decomposing in these cisterns, but the microscopic characters contra-indicate the supposition. No. 116 with its .010 part of albuminoid ammonia is as good a water as many previously recorded which yields less, while Nos. 120 and 121, with .005 and .007, respectively, seem, from the microscopic appearances, to be less desirable waters than even No. 116. The permanganate results in Nos. 116, 120, 122, which are from slate roofs, differ very noticeably from the others in this list which are shed from shingles. The comparatively large amount of free ammonia in No. 122 with its proximity to the vault, renders communication between the reservoirs a probability; but the small quantity of nitrates, and especially of chlorine, show this to be slight, if any. In view, however, of the possibility of danger, this cistern should be condemned.

Nos. 123 to 125 are undoubtedly bad waters, although the absence of free ammonia and nitrates proves freedom from sewage. The cistern of No. 123 was examined after the analysis and found to be in want of repairs; its contents rose and fell with the ground water. No. 124 was furnished in connection with cases of malarial remittent fever, which prevailed in the house supplied by this water. Its albuminoid ammonia distilled thus: .07, .03, .015, .005 = .024 part. The absence of sinks and stables, and small amount of free ammonia, show that there can be no recent animal matter to account for the chlorides. No particulars were furnished concerning the cistern from which No. 125 was obtained, except the verbal remark, in response to the inquiry of the analyst as to whether he was dealing with a very foul well or cistern water, that the cistern was in want of repairs and was not used much.

Nos. 126 to 129 were condemned as contaminated with sewage, the opinion being based on the fact of leakage and the proximity of vaults; on the incomplete oxidation of organic matter which had taken place in No. 127, and on the nitrates and microscopic characters in No. 128. No. 126 illustrates the difficulty which is sometimes presented in determining the presence of sewage in a cistern water from the laboratory examination alone. Nos. 120 and 126 were sent for analysis without information concerning the surroundings of the cisterns, the samples being simply lettered for identification. Leakage from the soil was established in No. 120 by the chlorine being larger than was consistent with soundness, unless the water had been highly charged with impurity from roof-washings, which was manifestly not the case, while the absence of sewage was proved by the small amount of free ammonia. But notwithstanding the favorable results of the albuminoid and permanganate processes, the water, on account of its sediment, was not considered unexceptionable. In No. 126, however, although leakage was distinctly proven, neither the ammonias nor the oxygen could discountenance the idea of sewage, nor could they prove its presence, for many sound cisterns had yielded similar results. The microscope indicated the water as organically impure, without showing that the impurity was derived from animal waste. The leak, however, was small, yielding only a total of 8 parts. At least one-half of this total must have come from the roof, leaving only 4 parts or less as due to leakage. Nevertheless, this small proportion contained 1.3 parts of chlorine. The ground water of a pure soil would have contributed earthy salts to a considerable extent along with this quantity of chlorine. The probability, therefore, was that the chlorine came from sewage infiltration, and an opinion to that effect was rendered. The surroundings of the cistern when made known to the analyst appeared to sustain this view of the impurity of its contents.

In Nos. 130 to 136 the nitrates present show these waters to be tainted by that which has percolated through the soil and lost its organic nitrogen by oxidation. These water samples may or may not be unwholesome, but the cisterns from which they were drawn are situated where their leaky condition exposes them to a possible inflow of organic impurity. The likelihood of this can be best determined by an inspection of the sources of filth in their neighborhood. Many of the waters from sound cisterns give ammonia; albuminoid and oxygen figures similar to those in this list. No. 131, for instance, may be compared with No. 52, and Nos. 130 and 134 with Nos. 48 and 49, but the characters of the sediment are essentially different.

Calcic carbonate is recorded as present in all these waters, but in No. 135 it existed in minute quantity compared with the total. On this account, together with the amount of chlorine and nitrates, sewage infiltration oxidized in its passage was inferred as a contamination of the water. From the analysis, it was uncertain whether this water was drawn from a well or a leaky cistern, and as no information accompanied the bottle, other than that it came from 106 Union street, Memphis, and as no person appeared to make inquiries concerning the result of the examination, a sanitary inspector was dispatched to the premises with instructions to bring therefrom a sample of the water supply and to make note of its source. The specimen returned, which was reported as from a cistern, was examined as to its total solids and amount of

chlorine, and these agreeing with the results already obtained, the cistern was recorded as leaky and liable to intrusion of sewage. This case possesses some interest, as an attempt was made by means of it to throw doubt upon the accuracy of the writer's analytical work in Memphis. Interested motives apparently lay at the bottom of this effort, the financial interests of individuals as opposed to the sanitary interests of the community. Two weeks or more after the writer had left Memphis, a card appeared in one of the papers, wherein a Mr. Moore stated that he knew a gentleman in Union street who had presented to the analyst a gallon of pure rain-water, which had been condemned after examination as from a leaky cistern. It fortunately happened that the water from 106 Union was the only sample from that street which was upon the record. Pure rain-water, understanding by that phrase water collected from the clouds or perhaps from the roof in clean dishes, certainly does not contain 29 parts of total solids of which 13 are lost on ignition, 2.7 are chlorine, and .549 nitric acid, while its ammonia is greatly in excess of .002 and its albuminoids seldom as low as .010. That some mistake had been made by the gentleman who collected the sample was apparent; and as, on several occasions, the writer had found that an explanation of anomalous analytical results could be obtained when honestly sought for, as in the case of the common salt in No. 86, the Wolf River clay in No. 112, and the lager beer and alcoholic traces in waters which were not recorded after the impurity in the containing vessel was detected, he believed that in this case also the explanation might be discovered. On instituting inquiries at 106 Union street, it was ascertained that Mr. Moore himself lived there; and as the man who knew the gentleman who collected the pure rain-water seemed to be intimately associated with the gentleman himself, it was felt to be useless to attempt to obtain the particulars of the collection, as the motives which dictated the publication of the card, instead of a communication to the analyst in the first instance, would be equally effectual in suppressing any investigation into the origin of the chlorine in the so-called pure rain-water. No notice was taken of the card at the time, but more recently when the gallon of pure rain-water made its appearance in print a second time, a friend of the writer who was cognizant of the circumstances rose to explain. The analyst is indebted to Dr. F. W. Reilly for his defense. But the explanation which is required is not how chlorine, &c., came to be discovered in a pure rain-water, but how they came *to be* there. The gentleman whom Mr. Moore knows, knows more about this than anybody else; or if he does not, he ought to.

The samples Nos. 137 and 140 illustrate rank pollution by sewage, with ineffectual efforts at purification by natural filtration. Urea gives no result by the permanganate process, and if decomposition has taken place it gives none by the albuminoid process, but when it enters a cistern or well there usually comes with it or with its remains, sufficient organic impurity recognizable by these processes to condemn the water.

Nos. 138 to 140 were from three neighboring cisterns situated in an unsanitary locality, with the drainage of the neighborhood tending to the position of the last mentioned. The house supplied by No. 140 was notably unhealthy; two cases of malarial remittent, of severe type, were reported from it, and four of yellow fever, during the few months preceding the analysis. This water has higher albuminoids than that of the New Orleans drainage canals.

Nos. 141 to 149 were specially selected samples. The amount of chlorine present in an underground cistern water having been made the measure of its leakage when present in excess of the quantity usually found in raised tanks, a large number of the Memphis cisterns were examined by means of the simple chlorine estimation. From the number so examined these specimens were sent for, that their character might be thoroughly investigated to illustrate the quality of water with which a given quantity of chlorine might probably correspond. The albuminoids in the majority suffice to condemn irrespective of the nitrates and chlorine present.

Nos. 141, 143, 146, and 148 are less charged with organic impurity. The free ammonia is also noticeably less in these than in the others. The microscopic characters are satisfactory only in No. 141. Where the leakage is established, and there is doubt as to the unwholesomeness of the water, the proper action is manifestly to condemn the cistern to disuse or repairs, according to its vicinity to vaults, stables, and like sources of impurity, to the direction of the drainage, and to the level of the ground water in relation to the depth of the cistern. The total solids in No. 149 and probably in Nos. 144 and 148 contra-indicate the use of the water irrespective of organic impurity. The absence of living organisms in No. 149 is noteworthy.

Four hundred and forty-nine Memphis cisterns, excluding the 9 samples above recorded in full, were examined as to their chlorine amounts, with the following results:

No. of cisterns.	Chlorine.
127	under .075 part.
82	.075 to .15 part.
82	.15 to .30 part.
158	over .30 part.
449	

Those containing under .075 part were reported as from cisterns undoubtedly sound, and as being probably pure waters. Where the chlorine ran from .075 to .15 the cistern was reported as probably sound, the chlorine increase being referred to organic matter from the roof which would tend to throw doubt upon the wholesomeness of the water. With the chlorine ranging from .15 to .30, leakage to a small extent was indicated, or a most unwholesome condition of the water from accumulations of organic matter. These cases were recorded as probably leaky; while, where the chlorine was in excess of .3 part, the leakage was considered established.

Nos. 150 to 182 are samples of undoubtedly good well-waters. A few, as in No. 158, have the dissolved solids somewhat high, but experience has shown that no evil effects can be attributed to them. Their proportion of earthy salts is small. No. 182 was the only specimen which gave a marked cloudiness on boiling. On account of the large loss on ignition the nitrates in Nos 179 and 180 were determined. In all the samples the free ammonia does not exceed .002, and the albuminoid ammonia is under .010 parts. The results of the permanganate deoxidations are strikingly different from those yielded by the stored rain-waters. Dr. Tidy, who relies mainly on the permanganate process, regards waters as of doubtful character which require more than .15 parts of oxygen. Few of those in this list exceed this amount. The chlorine varies much in quantity and gives little information of sanitary interest. It is sometimes stated that if the chlorine yielded by the well-waters of a given district is known, any increase in a particular water would give grounds for suspecting animal impurity. Theoretically, this appears to be sound reasoning, but practically there is not that uniformity in the chlorine figures of even a limited district which would enable one to form an opinion. Witness the varying quantities in the Grenada waters. The only value of the chlorine estimation is the testimony it bears to the nature of the inorganic matters which make up the sum of the total solids.

The microscopic characters are definite, the rotifers in Nos. 154 and 159 constituting the only exceptions. These animalcules are usually found in waters yielding larger albuminoid and oxygen figures. No. 177 is a sample of water as pure (using the word in both its chemical and sanitary sense) as can be found in nature. It is rain-water deprived of its atmospheric impurities by filtration through a bed of clean sand.

The surroundings of most of these wells are satisfactory. Elliott and Duckhill are settlements consisting of not more than a dozen scattered houses with the wells at a distance from sources of contamination, and, in the majority of instances, carefully protected. No. 165 is at a cross-roads, several hundred yards from the nearest house. Payne's place, No. 164, is a country house. The house in the village of Brandon, from which No. 150 was taken, is so separated from adjacent dwellings as to be virtually a country house; so, also, with some of the houses supplied by the Holly Spring waters. No. 180 is from beyond the city limits of Memphis. The Grenada wells, although situated in a comparatively settled locality, have no vaults in their neighborhood to permeate the soil and contaminate their waters. Surface receptacles and dry earth are in general use in Mississippi with the drainage away from the water source.

The list of well-waters which may be called of fair or usable quality is exceedingly small, containing only two samples, Nos. 183 and 184, out of eighty-nine examined. The former has the albuminoids rather high, but is otherwise satisfactory. The latter gives large permanganate results, which are believed to be from carbonaceous matter in the sample bottles.

Nos. 185 to 187 are the only waters which require to be condemned on account of their total solids, which consist largely of lime salts. Other specimens of well and cistern water have large mineral residues, but they are accompanied by organic traits which would condemn the water irrespective of the dissolved solids.

Nos. 188 to 194 are unwholesome waters from excess of organic impurity, but in none of them is there ground for supposing contamination from vaults. No. 188 is an extremely hard water; its excess of chlorine is apparently geologic. No. 189 does not represent a fair sample of the water furnished by the well. A new pump had been inserted on the day before the collection was made, and much organic matter which under ordinary circumstances would have lain quietly at the bottom was diffused through the water. The well from which No. 190 was drawn was in bad condition, its wood-work much decayed. No. 191 yielded a dark-colored hygroscopic and acrid matter in the residue. The loss on ignition was large from imperfect drying. This water was reputed excellent and wholesome. When the analytical results were made known, the impurity was referred by the owner of the well to certain foul, disused vaults in the neighborhood, but the distance of these vaults, the shallowness of the well, the direction of drainage, and particularly the absence of nitrates, seemed to contra-indicate this supposition. A close inspection by the writer excluded every possible source of impurity except that constituted by manure on the surface. The well was situated in a richly manured kitchen garden in which were many fruit-trees. The surface layer consisted of a dry, porous sand, but the tree-roots extended below this through the clay to the water-bearing stratum. The idea was therefore suggested that surface-water might be led into the well along the roots or through channels

formed by their decay. This theory of the contamination received support by a consideration of the surroundings of the well which yielded No. 192. Near by were no vaults or other sources of impurity, nothing but the manured soil and fruit-trees. Similar conditions were anticipated in No. 193, and when an inspection was made, the trunk of a large silver-leaf poplar was found to arise from the soil within 3 feet of the well, while the fence of the kitchen garden ran alongside. In the case of No. 194, the well was surrounded by large trees and an unused well half-filled with decayed leaves was situated within 20 feet of it. This sample differed from all the others in yielding its albuminoid ammonia in quantities which diminished 50 per cent. in successive distillates.

Nos. 195 to 202 are good waters notwithstanding the presence of the nitrates. But for the nitric acid no suspicion would attach to them. As it is, the surroundings of the wells appear to indicate that the nitrogen of the acid is well removed from its anterior state of organization. The three samples from Mobile are from a water-bearing stratum which is cut off from surface contamination by an impervious layer of clay. The nitrates are therefore the remains of organic matter which entered the stratum at its outcrop.

No. 203 has a higher albuminoid figure, but its small amount of dissolved solids and its microscopic characters place it among the usable waters.

Nos. 204 to 207 contain traces of nitrous acid, without any coexisting nitrates. No. 205 is apparently a good water; No. 206 is probably good. The well from which the latter was obtained had been cleaned out a few days before the sample was submitted and the water was not entirely free from the effects of the disturbance. No. 204 was also turbid from interference with its natural sedimentation. On account of the large loss by heat in No. 207 the nitric acid was determined, but with negative results. The microscopic characters of this water are decidedly inconsistent with purity, and in connection with the nitrites should cause it to be received doubtfully in spite of its freedom from albuminoids.

Nos. 208 and 210 are condemned on account of the free ammonia which they contain. In the latter the loss on ignition called for a determination of the nitrates. It is noticeable that in several instances of contaminated well and impure cistern water anguillula is present, unaccompanied by any other living forms, as in Nos. 42 and 43, already reported, and in Nos. 220, 230, 235, and 236.

In Nos. 209 and 211 the trace of nitrous acid is not associated with nitrates. They are both bad waters; in the latter the inorganic solids are sufficient to interdict its use. They consist mainly of lime salts.

Nos. 212 to 214 contain traces of nitrites along with nitrates. The last, however, is a good water in other respects except in containing an excess of dissolved solids. Organically it is pure, but the well which contains it is liable to invasion by unoxidized matters, and hence should be condemned. No. 207 gives similar albuminoid and permanganate results and contains also a trace of nitrites, but its freedom from dissolved solids and accumulations of oxidized nitrogen renders the well which furnishes it a less suspicious source than that which yielded No. 214. In No. 213 the nitrites, as in the two other cases, evidence the proximity of the organic store-house which furnished the nitrates, and the microscope testifies to impurity, although the free and albuminoid ammonia and the oxygen figures were low at the time of the examination, so low that the water would have been pronounced pure by any or all of the chemical methods which do not include a valuation of the nitrites and nitrates. The sample examined no doubt was pure, and a report to that effect would have been correct in so far, but the object of the sanitary officer in investigating a water comprehends more than an opinion on the half gallon submitted to him. The purity of this water depends upon circumstances which are liable to be changed by the first rain shower or other accident which will cause a more rapid inflow. The life in the sediment shows that there must have been more albuminoids in the water at a recent period, and the nitrites that the impurity may recur at any moment.

Nos. 215 to 239 are contaminated by sewage. In many the excess of inorganic solids depends entirely upon the presence of sewage salts, chlorides, alkaline carbonates, and nitrates. The free ammonia in some, as Nos. 231 to 234, is excessive; in others, as Nos. 225, 228, and 239, it has almost disappeared, but enough of the albuminoids persist to condemn the waters without reference to the existing nitrates. The presence of only a trace of nitric acid is noteworthy in the highly contaminated waters Nos. 231 to 234. This is owing to non-oxidation and not to destruction of pre-existing nitrates by sewage influx. No. 232, the least impure of these, shows the effort at purification by oxidation in the soil.

The permanganate results differ exceedingly in this list, from .0147 in No. 219 to 1.2099 in No. 231. The latter result was verified by repetition. Nos. 224 and 226 to 229 have the oxygen figure so large as to imply a vegetable origin to the organic matter. In these samples the albuminoid ammonia diminished by 50 per cent. in successive distillates. It might be assumed, however, that carbonaceous matters, when mixed with the animal albuminoids, retard the evolution of ammonia, but Nos. 231 to 234, which

have large oxygen figures, distilled their organic ammonia rapidly. In No. 215 th gen result first obtained and recorded was 1.1382, but this was so anomalous mistake was apprehended. The sample was contained in a drug-store alcohol b A fresh supply collected in a clean bottle gave the tabulated result. The im in this water depended on the vicinity of a cow-stable and a broken curbing admitted surface water in rainy weather. The well from which No. 216 was ob was near the only deep privy vault which remained in Holly Springs. The im in No. 217 appeared owing to the presence of trees and a highly manured surfac as in several instances already recorded. The unwholesome quality of Nos. 218 in Brownsville is undoubtedly owing to the neighboring vaults, as in No. 216. S conditions aggravated by an increased density of population supply the Memphis Nos. 222 to 230, with their large amount of sewage salts and organic impurity. of these, however, have a good deal of calcic carbonate and sulphate, and cloud d on boiling. Three cases of typhoid fever were reported by Dr. W. W. Taylor, tary of the local board, in the house supplied by the well from which No. 22 drawn. No. 222 contains a large quantity of chlorides and nitrates, yet the micro field was full of life. This sediment may be compared with that of the sampl 149, which, with similar pollution but with increased solids, gave a perfectly dead

Nos. 231 to 234 are samples of the impure ground water of New Orleans. Th simply diluted sewage. (See analysis No. 267.) Alkaline carbonates are pres large quantity in these waters.

Nos. 235, 236, and 239 are shallow wells in Mobile, Ala. They obtain their im by inefficient filtration. Nos. 237 and 238 are deep wells in the same city, co inated by leakage from the impure ground water. The former is but 25 feet dee its solids show its water supply to come from the stratum which is penetrated b deeper wells, Nos. 200 to 202.

No. 240 is a pure spring water. No. 241 is a fair water, and would no doubt b proved in quality if some effort were made to protect the spring from accidental rities. The filtration is imperfect in Nos. 242, 245, and 246. They are rain w modified by their passage through sand. The ammonia in No. 243 is derived fro neighboring gas-works. No. 244 must be received as a dangerous water. The lost knows nothing of its surroundings, but the large amounts of nitrous aci chlorine show impurity to be in the vicinity. The ammonia, which in No. 143 innocuous remains of atmospheric precipitation, must in this case be looked upo suspicion. A communication from Dr. F. W. Reilly, inspector National Board of H who sent the sample for examination, states that this water was much used b people of Memphis in the early days of the city, and that it was a reputed ca diarrhea. After the albuminoid ammonia was distilled from this sample, the alk liquid was permitted to remain in the retort for seventy-two hours, when a fu distillation was made, but without the discovery of any more ammonia. Nos. 24 246 are from the same source—springs which constitute the hydrant supply of th of Mobile.

River waters are so variable in quality from temporary disturbing causes that can be predicated of their character from a single examination. As in dealing questions of climate, the maximum, minimum, and mean annual temperatures be known to insure an appreciation of the subject, so with regard to running w their maximum, minimum, and mean yearly impurity must be ascertained with cient accuracy before an opinion can be warranted as to their wholesomeness. a river is low there is usually a tendency to the deposition of suspended matters. water, therefore, corresponds with the period of minimum organic impurity. H rains and snow-meltings contaminate the stream by bringing into it the sewage atmosphere—the various organic substances which have been seen to yield so albuminoid ammonia. The increased flow prevents the deposition and conse purification which ordinarily take place. Surface erosion, in addition, loads the with turbidity, and organic matters from the soil are diffused through it unde cumstances favorable to their solution. High water, therefore, corresponds t period of maximum impurity. If the character of the water is known at these stages, the variations in quality which occur during the year can be ascerta They will be proportioned to the variations in the volume of the running water.

No. 247 shows the maximum impurity of Wolf River; No. 248, the maximum o Mississippi taken at New Orleans when the river was above the danger line. Sa illustrative of the minimum of these streams were not obtained. No. 249 show condition of Wolf River water when the stream, as reported by Major Benyaurd, U States Engineer Corps, was at medium current and stage. No. 250 is from River at a time when the flood in the Mississippi caused a stagnation in the cu which extended as high as the Memphis water-works. Its impurity is similar to found in Mississippi water No. 251 collected on the same day, the river being fully 10 feet over low-water mark. No. 252 gives the character of the Missis water when the stream was lower—1 foot 7 inches above low water.

None of these waters are sufficiently pure for use as a drinking supply. The albuminoids are excessive.

Nos. 253 to 255 illustrate the process of purification by settling as it takes place in Mississippi water, in Wolf River water from Memphis and in Wolf River water from Raleigh, 9 miles above the city of Memphis. The Wolf at this time was at medium stage and the Mississippi 7½ feet above low water. The waters were permitted to stand for three days before analysis. The results speak markedly in favor of Mississippi water, and the cause is obvious. The sediment consisted chiefly of sand, which settled in the time allowed, while the clay particles continued to cloud the Wolf River samples. This subject has been already referred to in discussing the characters of mineral sediment.

Nos. 257 to 259 have no bearing on the quality of Wolf River, although they were sent to the analyst as illustrative of the character of that water at its purest. These are manifestly not running, but stored waters, subject to all the purifying influences which have been seen to change impure rain into pure cistern water. There is more than a verbal distinction here. The water was indeed river water when introduced into the cisterns. It was rain or spring water before it became river water, but we speak of a water not as it has been but as it is. So, in No. 260, which is Wolf River water filtered through animal charcoal, the analysis testifies to the efficiency of the filtration and not to the purity of the river water. This specimen in its natural condition yielded .037 part of albuminoid ammonia. No. 261 is Mississippi water filtered through wood charcoal. The unfiltered water gave 0.36 of organic ammonia. The large amount of free ammonia in this instance is believed to have been derived from the charcoal. Its action on the permanganate was similar to that of the pure water used as a standard.

The results were so unsatisfactory in No. 262, which was represented as Mississippi water filtered through sandstone, that an inspection of the arrangements was made. The filters consisted of sandstone basins, set in a frame-work like a washstand, with vessels placed underneath to collect the filtered water. The sandstone was choked and foul, and colonized the filtrate from its under surface. The passage was so tedious that more water was used from the basins than from the receivers. No. 263 is Mississippi water, with an albuminoid figure of .035, as filtered into the interior of a sandstone keg. The hollow "filtering stone" lay in the bottom of a tank, and was filled through its pores by the pressure of the superincumbent water. A ventilating pipe extended from the interior of the keg to above the high-water mark of the containing tank.

During the writer's stay in Memphis many of the citizens were interested in the quality of the hydrant or Wolf River water, some condemning it in unmeasured terms and others lauding it as one of the best and purest of natural waters. Appearances were certainly against it. Even when reported by the engineer officers as at medium stage and current, the water of this stream was loaded with reddish clay and with suspended and dissolved organic matters. The arguments of its advocates comprised the results of certain analyses, which were made some years ago, and the organic purity of the water, as shown by the present analyst, in certain sedimented and filtered samples. The purity established by the old analyses was a chemical purity. The water did not contain so much inorganic solids, so much calcic and magnesic carbonates and sulphates, &c., per gallon, as that of certain other rivers; therefore it was stated as much purer than the average of river waters. So far as inorganic solids are concerned, both the Wolf River and the Mississippi might contain twice as much as they do without imputation on their wholesomeness, though of course they would be more impure, viewing their waters from the chemical standpoint. But this inorganic purity or impurity is not the point at issue in a sanitary investigation. This is not the purity with which the people who drink the water are concerned. Water which contains 10 grains of common salt per pint is chemically less pure than that which contains 2 grains of strychnia in the same quantity. But the sanitarian and the people are concerned about the quality of the dissolved matters. The common salt in the one is harmless, the strychnia in the other is a deadly poison. The first, though chemically impure, is a wholesome water; the second, though containing less of solid matter, is not wholesome. These old analyses say nothing of the organic matter except what may be learned from the loss on ignition.

The purification which takes place in cisterns has been explained above as altering the water so completely that when it is drawn thus pure it is not Wolf River water. Filtration through charcoal exercises even a greater influence over the water. (See Nos. 260 and 261.) Professor Wanklyn experimented with the silicated carbon filter. He made a poisonous solution of strychnia, filtered it, and drank a pint of the filtered liquid, but he did not bring forward these experiments to prove that strychnia is not a poison, only as illustrative of the value of charcoal filtration. Nor can the purity of Wolf River water after filtration be used as an argument in favor of the wholesomeness of the natural water. It is but another illustration of the value of charcoal filtration. The only allowable inference is that Wolf River water is susceptible of purification. But so is sewage or strychnia water. That they can be purified does not prove

them pure. The people of Memphis are interested in the quality of Wolf River water as supplied to them by the water company, and not as it exists when purified by artificial means. That the water selected for the supply of a large city should be a wholesome water in its natural condition, and irrespective of any artificial treatment, is one of the first principles of hygienic science. Wholesale sedimentation or filtration will improve a fair or usable water, but it cannot be relied upon to make an unwholesome water pure. What may be done by the individual cannot always be accomplished on the large scale for the community. The Mississippi water, when at its purest, is an allowable water. The condition of the Wolf River water, when at that stage, is unknown. The experiments indicate that it is not so good as that from the larger stream. Neither is suitable for a supply at other seasons. But if better cannot be had, what is to be done? Underground cisterns furnish a pure water when they are sound and clean. But their lime lining is subject to a process of disintegration and solution. They fall into decay insidiously and become leaky. They can only be trusted to furnish a wholesome water when they are sunk in an uncontaminated soil. That of Memphis is not pure. Its cisterns should be used only until a supply of usable water is introduced from beyond its limits. If no other source is available, an attempt must be made to purify the water of one or other of the rivers so as to make it reliable at all seasons. Undoubtedly the Mississippi furnishes a water which responds more readily to treatment directed to its purification. Its sand and clay settle sooner than the clay of the Wolf River, and they do not form so impervious a stratum on the surface of a filter. But the engineering and financial difficulties which lie in the way of a Mississippi supply are said to be too great for the abilities of the present. Money is therefore being expended on the Wolf River works to improve the water supply. If the water company can furnish a supply which does not exceed .015 in its albuminoids it would be more reliable than the cistern water; and with care and money the required purification can be effected probably with the expenditure of less of each than would be required to overcome the engineering difficulties involved in a Mississippi supply of equal purity. The water at Raleigh, 9 miles above Memphis, is loaded with the same clay which contaminates the river below that point. No advantage would therefore be derived from bringing the water from that place. The same expenditures would be involved in its purification. So far as the new water company is concerned, the character of the water supply furnished will depend upon money and method. But, as the source is so frequently impure, carelessness may at any time give the city an unwholesome supply. To protect the interest of the people, the health board should have a water inspector to watch the condition of the water supply, and notify it when the albuminoid ammonia exceeds a certain figure.

Nos. 264 and 265 constitute the ice supply of New Orleans. The swamp water was taken from beyond Broad street; the sewage from the Orleans drainage canal. Urea in the latter gives excess of ammonia. The chlorine results show the proportion of animal waste in each. Carbonaceous matters are large in both. From the former, the albuminoid ammonia distilled in quantities which diminished one-half in successive distillates. From the latter it was evolved more rapidly. The nitrous trace shows oxidating influences to be active in both.

The Potomac water supply may be compared with the Wolf River samples already recorded.

The Ship Island specimen will no doubt give better permanganate results when the well is older. The sample was collected soon after the borings were made. Its sediment was small and gave no increase to the albuminoid ammonia when shaken up with the supernatant water before distillation.

SECTION XI.

ON ULTIMATE ANALYSIS AS COMPARED WITH OTHER PROCESSES.

When the writer was directed by the executive committee of the National Board of Health to examine into the water supply of certain towns and villages in the Southern States, the method of analysis to be adopted in the work required the most careful consideration. Three processes were in use by sanitary analysts for the estimation of the organic impurity in water; and each of these was warmly supported by its advocates, who at the same time questioned the results obtained by the other methods. Dr. Frankland upheld his combustion process as the only accurate method by which the organic matter could be estimated. Professor Wanklyn asserted the nitrogen estimations by combustion of the residue to be valueless, and held that the position of a given water in the scale of impurity could be more accurately defined by the amount of albuminoid ammonia distilled from it. Dr. Tidy sustained the permanganate results as more valuable than the difficult and doubtful issues of the combustion and the uncertain fractional yield of ammonia from the albuminoids. Acknowledging, however, that Dr. Frankland's process was theoretically the best, he showed that his

permanganate results agreed in general terms with those obtained by combustion, and hence claimed accuracy over Wanklyn's method and simplicity over Frankland's.

The views held by the writer were to the effect that each of these processes yielded information with regard to the sanitary value of water; that the carbon and nitrogen of the combustion process gave expression to the amount of the organic matter; that the albuminoids of vitality were similar in composition, and that the ammonia distilled from them, although failing to account for the whole of their nitrogen might be viewed as an expression of their quantity; and that the permanganate oxidations might be considered as measuring the blackening which takes place on ignation. These views rendered the first process unnecessary by substituting for it a combination of the other and simpler methods. But as the action of permanganate in the cold is slow, while a number of experiments conducted at the boiling point showed consistency in their results, the process was modified accordingly. On returning from Memphis in December, 1879, the writer was gratified to find that in the new edition of Professor Wanklyn's book he makes use of a permanganate process with an iron ending to aid his albuminoid process in estimating the quality of the water. More recently Dr. Frankland, in his treatise on the subject, acknowledges that in certain cases the permanganate affords results which are consistent with those yielded by combustion, and describes the method with the iodine measure of excess as adopted by Dr. Tidy. These concessions on the part of opposition leaders suggest that the views of water analysis herein expressed are correct.

With regard to the combustion process, the precautions which are taken to prevent atmospheric contact during evaporation show that even its advocates acknowledge the liability to error from this cause. Its opponents suggest at the same time the impossibility of evaporating a water to dryness without loss of organic elements, especially in the presence of sulphuric acid oxidized from the sulphurous by the destruction of nitrates. The error produced by loss of free ammonia in spite of the fixation by the sulphur acid is acknowledged and provided for by Dr. Frankland. Loss of nitrogen may occur in certain cases when oxygen from the cupric oxide peroxidizes nitric oxide; lastly, the whole process is susceptible to error, which, in the laboratory of the inventor, amounts to .005 part of nitrogen adventitiously introduced. The first analysis given in Dr. Frankland's book is a rain-water which contains .007 parts of nitrogen and .029 parts of free ammonia. The correction for the ammonia lost during the evaporation is .006 parts of nitrogen; that for nitrogen adventitiously introduced is .005 parts, making .013 parts of correction for error in dealing with .007 parts of nitrogen in the residue.

But allowing the nitrogen in all cases to be determined with accuracy, the interpretation of the results of the process remains to be considered. The method is tedious and requires the utmost care and delicacy of manipulation to insure success. The process when finished announces that the residue of 100,000 parts of water contained so many parts of carbon and so many of nitrogen. A sample which yields high results is of necessity charged with large amounts of organic matter, and is correspondingly dangerous. The limit of carbon and nitrogen consistent with wholesomeness has been defined with as much certainty as the unknown nature of organic matter will permit, and waters are classified as good, usable, or wholesome in accordance with the carbon and nitrogen figures. But there is nothing absolute in all this. The elementary determinations merely show the position of a given water in the relative scale so constituted.

It is claimed by Dr. Frankland that the ratio of carbon to nitrogen will indicate, in surface waters at least, whether we are dealing with animal or vegetable organic matter. In the former the carbon is to the nitrogen as 3 or more to 1; in the latter as 4 or more to 1, "If the proportion be as low as 3:1, the organic matter is of animal origin, if it be as high as 8:1, it is chiefly, if not exclusively, of vegetable origin. Between these proportions the analyst must be guided in his opinion by the knowledge of the surroundings and of the source of the water, &c." It is thus conceded that there is a large number of cases where the ratio of the elements is of no value in this connection; and this number is largely increased by the changes which are going on in the water. The formation of carbonic and nitric acids and ammonia eliminates both the elements, and while carbon is thus entirely lost to the ultimate analysis, ammonia may or may not remain to add to the amount of nitrogen. The original ratio is changed by the process of oxidation, so that the albuminoids of vegetable matter persisting after the oxidation of carbonaceous substances may give a ratio indicative of animal origin. Besides this, the existence of a natural water in which animal or vegetable matter exists alone may be questioned. The use of the microscope authorizes this statement, irrespective of such theoretical considerations as the general diffusion and mutual dependency of the two forms of matter. A water which contains a dangerous infilterage of animal waste may be so loaded with carbonaceous matters of harmless quality that its vegetable character alone would be inferred from the ratio. Take, for instance, a leaky Memphis cistern containing water shed from a shingle roof and contaminated by the neighboring vaults. Here deposited carbon from the roof and carbonaceous mat-

ters from the wood obscure the animal nature of the dangerous contamination. Since the ratio of the elements yields no trustworthy evidence and the results of the combustion form simply a scale of relative impurity it is doubtful if the information furnished repays the time and care expended on the experiment.

An essential part of Dr. Frankland's method consists in the determination of the nitrites and nitrates which are viewed as formed from the nitrogen of animal waste and as constituting the "skeleton of sewage." The value of these products of the oxidation of nitrogen has already been discussed. They are the remains of former contamination but have no bearing on the present wholesomeness of the water, unless the proximity of the organic matter from which they are derived can be deduced from them or from some other part of the investigation.

The argument on which Dr. Frankland bases the animal nature of the organic matter in which these originate is by no means clear. Nitrates are formed from vegetable nitrogen as well as from animal albuminoids. Nor is it clear why these salts should be elected to represent the "previous sewage or animal contamination" of a water. They are liable to decomposition. The chlorides of sewage are more characteristic of animal waste than the nitrates which may or may not be formed from it. They are also more permanent. If it is necessary to estimate previous sewage, the chlorine is more reliable as a measure; but we are not concerned with the geologic history of a water, the chlorine, nitrites, nitrates, and ammonia are only of interest to the analyst as throwing light upon *recent* passages in the course of a water supply.

The permanganate process which is substituted in the foregoing analyses for the carbon determinations of the combustion method, is sufficiently accurate for our sanitary purpose. A relative scale of impurities can be formed by it and the position of a given water assigned as satisfactorily as by the ultimate analysis. The uncertainty as to the character of the matter with which we are dealing renders scientific accuracy in the determination of the carbon unnecessary. The volume of oxygen required by the organic matter in its destruction by a given method gives as clear a view of the unknown organic material as the volume of carbonic acid produced by its combustion. The shortcomings of the process have already been alluded to and illustrated.

Professor Wanklyn's method of rating the water by the ammonia and albuminoid ammonia which can be distilled from it does for the nitrogen what the permanganate does for the carbon. It gives a view of the unknown albuminoids in the water as satisfactory after its kind as that furnished by the total nitrogen of the actual combustion. Its failure in certain cases to indicate contamination has been pointed out. The vegetable character of an organic matter may be inferred from the excess of oxygen required as compared with the organic ammonia, certainly with as much probability as from the ratio of organic carbon to organic nitrogen. An infusion of sawdust gave .045 mgrm. of albuminoid ammonia and required 8.137 mgrms. of oxygen, which is equivalent to stating that the carbon was greatly in excess of the nitrogen. Albumen from blood gave .480 of organic ammonia and required only 3.399 mgrms. of oxygen. But the history and surroundings of the water, the quantity of chlorine, and the microscopic appearances of the sediment must be carefully studied to arrive at an opinion on the probable quality of the organic matter.

In view of these considerations, it is believed that the method adopted in the foregoing analyses will meet with the approval of those who have carefully studied this sanitary problem.

APPENDIX N.

SANITARY SURVEY OF SELECTED PORTIONS OF THE CITY OF BALTIMORE, MD.

By Dr. C. N. Chancillor.

CORRESPONDENCE RELATING TO AND REPORT UPON A SANITARY SURVEY OF A PORTION OF THE CITY OF BALTIMORE, MARYLAND.

Health Department, City Hall,
Baltimore, February 6, 1880.

Dear Sir: I have the honor to inclose to you resolutions which, in pursuance of the action taken at the meeting of yesterday, were laid before his honor Mayor Latrobe this morning and by him transmitted to me to be forwarded to you.

Very respectfully, yours, &c.,

JAMES A. STEUART,
Commissioner of Health.

Dr. J. S. Billings, U. S. A.,
Vice-President National Board of Health, Washington.

Resolved, That the National Board of Health, in conjunction with the State and city boards of health and the physicians in charge of the quarantine hospital, be, and they are hereby, respectfully requested to communicate in writing to his honor the mayor of Baltimore, through the board of trade of Baltimore, their views and opinions as to the necessity for the establishment of additional quarantine facilities for the port and city of Baltimore, together with their recommendations for a proper location of the same; and that, on the receipt of such communication, his honor the mayor be requested to urge the city council to take immediate steps to carry out and perfect such recommendations.

Resolved further, That the same gentleman be requested to give their views as to a proper system of drainage and sewerage, or otherwise, for the city of Baltimore, in order to protect and guard against epidemic or contagious diseases; and that, on the reception of the same, his honor the mayor request the city council to authorize the appointment of a commission of medical experts to devise and recommend a suitable plan or to take such other steps as in his judgment is most advisable to insure the city from the creation or spread of epidemic diseases.

[Extract from minutes of a meeting of the executive committee of the National Board of Health, dated February 6, 1880.]

The vice-president stated, in connection with the letter of Dr. Steuart, that the president and himself had, in accordance with previous understanding with the executive committee, visited Baltimore yesterday (5th), and, meeting the quarantine officer of the port, the health officer of the city, the secretary of the State board of health, the president of the board of trade, and others, had gone down the river, looked at various points in connection with the quarantine, and, returning, had an interview with these gentlemen, as well as with the mayor of the city, during which the question of the quarantine, sanitary condition of Baltimore, and the necessity for sewerage was discussed by members of the State and local boards of health, the collector of the port, and others; that the meeting was informally organized with the mayor in the chair; that a motion made by Mr. Thomas, the collector, was adopted, to the effect that the National Board of Health or its executive committee be requested to state to the mayor of Baltimore their views in regard to the quarantine and sanitary condi-

tion of the city of Baltimore and the necessity for sewerage; and that an amendment was subsequently adopted asking the State board of health and health officer of the city to join in the statement. After some discussion the following resolutions were adopted by the committee:

"Whereas his honor the mayor of Baltimore, and other gentlemen representing the varied commercial interests of that city, have signified their wish to have a written expression of the views of the National Board of Health as to the sanitary advantage likely to be gained by a removal of the quarantine station in the harbor of Baltimore from the present locality to a point some miles lower down the river; and also as to the desirability and importance of immediate action by the city and State government looking to the establishment of a complete system of sewerage as a means of improving the sanitation of the city and of anticipating troubles which may be expected to arise from a continuance of the present mode of disposal of its excremental filth; and whereas two members of the National Board of Health, having visited Baltimore, and having held a conference with the said parties and with the health officers of the State and city, after a personal inspection of the present quarantine station and of other points in the river, with a view to said removal, have reported to the executive committee the facts which came under their cognizance and the opinions expressed by the authorities of Baltimore: Therefore,

"*Resolved*, 1st. That this committee consider that the continuance of the quarantine station of Baltimore at its present site is fraught with danger to the sanitary interests of that city, both because of its close contiguity to the pest-house, which is established on the quarantine grounds, and of the danger of communicating disease from infected ships in quarantine to other shipping entering or leaving the port, and that in view of these facts the removal of said quarantine station to a point not nearer to the city than the Little Hawkins or Leading Point, where there may be adequate facilities for complete isolation, seems indispensably necessary, while the pest-house should be retained at its present location as more accessible to the city, where small-pox is more likely to originate, and as being sufficiently remote from the proposed quarantine station.

"2d. That in order to secure, as far as practicable, harmony of views and uniformity of action as to rules and regulations for the treatment of vessels believed to be infected or coming from infected ports without clean bills of health from United States consular officers, the National Board of Health having last summer drawn up a set of such rules and regulations to meet the then existing emergency, being assisted in the performance of such duty by the quarantine authorities of New York and Baltimore, now propose, as intimated in its annual report (supplement to Bulletin, p. 3), to 'revise these rules after consultation with the State and local authorities, who have had experience as to their practical operation,' and does hereby invite the quaran- officer of Baltimore to assist in such revision.

"3d. That this committee considers a complete system of sewerage for the removal of excremental filth indispensable to the preservation of the public health in the city of Baltimore, and heartily indorses the recommendations on the subject contained in the last biennial report of the secretary of the State board of health of Maryland.

"4th. That this committee respectfully recommends to his honor the mayor that steps be taken, as soon as practicable, to have made—1st, a topographical survey of the city by competent engineers, in order to prepare accurate countour maps showing the levels and the best outlet point for such sewerage; 2d, a sanitary survey, as distinct from such topographical survey, and connected with a careful house-to-house inspection, in order to determine the existence and magnitude of any sanitary evils which should be remedied.

"*Ordered*, That copies of the foregoing resolutions be furnished to the different gentlemen before mentioned as having requested this expression of the views of the National Board of Health, accompanying the same with a letter, in which any additional explanation thought necessary may be made by the president."

WASHINGTON, D. C., *February* 6, 1880.

DEAR SIR: In accordance with the request of the meeting held at Rennert's Hotel yesterday afternoon, at which you presided, I have the honor to transmit the inclosed preamble and resolutions adopted this morning by the executive committee of the National Board of Health, which have been submitted to the health authorities of the State of Maryland and of the city of Baltimore for their concurrence.

It is earnestly hoped that the proposed improvements will be commenced at as early a period as may be possible.

Very respectfully, your obedient servant,

J. L. CABELL,
President National Board of Health.

General F. C. LATROBE,
Mayor of Baltimore, Md., &c.

[Extract from executive minutes of February 27, 1880.]

Ordered, That the request of the city of Baltimore, when received from the mayor, be referred to the president of the Board, with a request that he will visit Baltimore, confer with the State and local health authorities, and report to the committee his recommendation in the matter.

MAYOR'S OFFICE, CITY HALL,
Baltimore, March 5, 1880.

To the President and Members of the National Board of Health:

GENTLEMEN: I have this day received a certified copy of a resolution passed by the city council of Baltimore, a copy of which I herewith inclose, by which I am authorized to invite the National Board of Health to institute and conduct, under its auspices, a sanitary survey of the city of Baltimore, or such portions of it as they may deem necessary.

I have the honor to request that your board will make such a survey as is indicated in the resolution referred to.

Very respectfully,

FERDINAND C. LATROBE, *Mayor*.

Whereas the National Board of Health has expressed the opinion that a sanitary survey of Baltimore is important in the interest of the future health of the city: Therefore,

Be it resolved by the first and second branches of the city council of Baltimore, That his honor the mayor be, and he is hereby, requested to invite the National Board of Health to institute and conduct, under its auspices, a sanitary survey of the city, or such portions of it as they may deem necessary.

NATIONAL BOARD OF HEALTH,
Washington, D. C., March 8, 1880.

SIR: I have the honor to acknowledge the receipt of your communication of the 5th instant, transmitting copy of a resolution of the first and second branches of your city council inviting the National Board of Health to make a sanitary survey of your city, and to state that the papers have been referred to the executive committee of this Board.

Very respectfully,

T. J. TURNER,
Secretary National Board of Health.

Hon. F. C. LATROBE,
Mayor of Baltimore, Md.

NATIONAL BOARD OF HEALTH,
Washington, D. C., April 8, 1880.

SIR: In compliance with the request contained in a resolution of the city council of Baltimore, transmitted to this Board in your communication of March 3, the executive committee has this day appointed Dr. Charles W. Chancellor a special sanitary inspector to be assigned to the duty of making a sanitary survey of selected portions of the city, and has instructed me to communicate this fact to you, and to request that you will give to Dr. Chancellor, in conjunction with the health commissioner of the city, who has been requested to co-operate with him, such facilities and such authority as may be needed to enable them to have entrance to and make the necessary inspections.

I take occasion to recall to your remembrance the statement I made to you in a personal interview to the effect that it is entirely beyond the scope of the power of this Board to extend pecuniary aid to States or municipalities for purposes of local sanitation. It is therefore not with any view of relieving the city of Baltimore from any part of the expense of improving its sanitary condition that the partial survey about to be instituted under the auspices of this Board has been ordered by the executive committee. It is done in conformity with the provisions of the law to obtain accurate data on which the advisory function of the Board can be intelligently exercised and enforced, with the expectation that the work will be followed up by the authorities of the city to its proper conclusion.

Very respectfully, your obedient servant,

J. L. CABELL,
President National Board of Health.

General F. C. LATROBE,
Mayor of Baltimore.

NATIONAL BOARD OF HEALTH.
Washington, April 8, 1880.

DOCTOR: I am directed by the executive committee of the National Board of Health to inform you that, having decided to comply with the request of the city council of Baltimore as transmitted by his honor the mayor in a communication dated March 5, addressed to this Board, it has this day appointed you a special sanitary inspector, to be assigned to the temporary duty of making a sanitary survey of selected portions of the city in conjunction with Dr. Steuart, health commissioner, so far as he may be willing to extend assistance in the way of counsel and co-operation.

You are accordingly instructed to call upon those officers and to request in behalf of this Board that they will offer you every facility in their power to enable you to perform satisfactorily the important duty which has been assigned to you. To this end I inclose a letter addressed to General Latrobe, which makes known the wishes of the Board and solicits his official co-operation. This open letter you are at liberty to read before delivering it to the mayor.

The selection of the localities to be inspected is left to your discretion after conference with Dr. Steuart, but it is suggested that the inspections should not be confined to the localities which are manifestly in the worst sanitary condition. It may be important to show that even some of the apparently best parts of the city are not exempted from dangers under the system which has heretofore prevailed of disposing of excremental filth. It is the desire of the Board that the partial survey now ordered shall demonstrate to the satisfaction of the council the imperative necessity of a general system of sewerage of Baltimore.

It is suggested that you invite the special attention of the authorities of the city to a report in the Baltimore Gazette of Thursday, April 8, of four deaths from scarlet fever in three days, with two more children dying in the same house, No. 340 East Madison street, and of the probable local cause of this great mortality as ascertained by sanitary inspection.

It is requested that in making house-to-house inspections you will use the schedules of questions contained on the blank forms which have been furnished you, but that you will also collect any other information which may be pertinent to the general objects of the survey.

The amount appropriated by the Board to be expended under your direction for this survey, including your own pay of $10 per diem while actually engaged in the performance of your duties, is strictly limited to $700. The committee feels assured that you will disburse the amount placed under your control with the utmost economy, so far as may be consistent with the attainment of the ends had in view, and that for every dollar expended there shall be an adequate service rendered.

You will certify to the correctness of all accounts forwarded to this office for settlement on forms of vouchers which will be furnished you on demand.

Very respectfully, yours,

J. L. CABELL,
President National Board of Health.

Dr. C. W. CHANCELLOR,
Baltimore, Md.

NATIONAL BOARD OF HEALTH,
Washington, September 30, 1880.

SIR: Referring to my communication of April 10, announcing the appointment by the executive committee of the Board of Dr. C. W. Chancellor as a special sanitary inspector to be charged with the duty of making a sanitary survey of selected portions of Baltimore City in compliance with a request to that effect by the city council, I have now the honor to inform you that said survey has been made in conformity with instructions from this office, and to transmit to you Dr. Chancellor's report of the same. It is pertinent to remark that Dr. Charles F. Folsom, then secretary of the State board of health of Massachusetts, who had made a special study of the methods of sewerage and disposal of the excremental filth of cities both in Europe and in this country, was appointed by this Board to consult with Dr. Chancellor in the progress of his work and in the preparation of his report, in the general conclusions of which he has expressed his concurrence. I avail myself of the occasion to say that the facts cited in this report abundantly justify the opinions expressed in the preamble and resolutions adopted by the executive committee February 6, 1880, which having been submitted to the health authorities of the State of Maryland and the city of Baltimore, and having received their concurrence, were transmitted to you as chairman of a meeting held at Rennert's Hotel on the preceding day, at which meeting a resolution was passed soliciting such expression of opinion on the part of this Board. I will add that, while the executive committee earnestly reiterates the advice then given, proper steps be *immediately* taken looking to the inauguration of a systematic sewerage of the city

of Baltimore as an indispensable means of protecting the public health, it concurs with Dr. Folsom in thinking that it would be premature to recommend any particular plan until there shall have been made by competent engineers an exact topographical survey of the city, with contour-maps, in order that the problem of the carriage and final disposal of the sewage of the entire city on some uniform plan may be intelligently considered.

Very respectfully, your obedient servant,

J. L. CABELL,
President National Board of Health.

Hon. F. C. LATROBE,
Mayor of Baltimore.

REPORT.

PART I.

To JAMES L. CABELL, M. D.,
President of the National Board of Health, Washington, D. C.:

SIR: According to instructions received from you on the 8th day of April, 1880, I immediately proceeded to make house-to-house inspections of selected portions of Baltimore, with the view of determining, if possible, the sanitary needs of the city. In this work I have been most efficiently aided by the police department. A number of their most intelligent officers were detailed to make preliminary inspection, which they did in a thorough manner, thereby greatly facilitating the investigation.

In collecting the data upon which this report is based, as well as in the preparation of the same, I am also indebted for valuable assistance to Major Richard Randolph, civil engineer, who gave special attention to all questions involving engineering problems.

A COMPREHENSIVE INSPECTION NEEDED.

It is to be regretted that the inspection could not have been more comprehensive, so as to have enabled us to determine the actual sanitary condition of the entire city, instead of embracing only those districts which were regarded as presenting a specially good field for observation. A careful examination of the facts collected, however, will furnish a reliable basis for sanitary reasoning on several points of the most important character. They relate to seven out of twenty wards of the city, and may be summed up as follows:

FIRST DISTRICT.

Second Ward.—Embracing portions of Broadway, Thames, Ann, Fell, Wolf, Block, Philpot, Lancaster, Bond, Dallas, Caroline, Register, Durham, and Aliceanna streets. In this district, which embraces what is known as the typho-malarial district, 547 houses were inspected, containing a total of 3,653 inmates, or an average of about 6¼ persons to a house. In quite a number of instances, however, this average does not properly represent the real condition of things, and, as will be shown further on, there are not a few cases of overcrowding. In 130 of these houses, pumps are used to supply the inmates with water, which is represented to be "bad" or "not very good" in many instances. Seventy-four houses are without any special water supply, which doubtless means that their inmates make use of some convenient pump. The remaining houses are supplied with hydrant water. Of the privies, 118 were found to be in bad condition, and many of these were overflowing, saturating the ground with their liquid contents, polluting foundations, and occasionally flooding cellars with stagnant and offensive fluids. The smell from many of these cess-pools was extremely noxious. Of the whole number, only 30 are self-draining; the remainder are said to be cleaned once, twice, or three times a year. The great majority are not cleaned oftener than twice, while many are not emptied oftener than once annually. In the case of 85 houses inspected on South Bond, South Dallas, South Caroline, Lancaster, and Thames streets, the greatest depth of privies was found to be 40 feet, while the minimum and ordinary depth was only 6 feet; the maximum distance from the house is 90 feet, while in many cases the privies are attached to the sides of the houses or within 2 or 3 feet of them, and discharge their offensive effluvia through open windows or doors into the sleeping or sitting apartments. Some of the lots have, at different times, had as many as five privy vaults, which, after becoming full, have been successively abandoned for a new vault, or rather for another hogshead, it being found cheaper to cover over the full cess-pool and sink a fresh pit or hogshead than to empty one that has already become full. In this way the ground space of a number

of lots has been literally honeycombed by a succession of privy-pits, which, after being filled with decomposing excrementitious matter, are covered over and abandoned. It needs no elaborate argument or expert knowledge to prove that malarial poisons are being constantly generated and brought to the surface, to contaminate the surrounding atmosphere with their baleful influences. In 256 houses in this district there are no cellars, and, in most cases, no ventilation beneath the ground floor; in 23 instances the cellars were found damp and in bad condition, filling the air with their foul odors.

SECOND DISTRICT.

Fifth ward.—Embracing portions of Jefferson, McEldry, Monument, Asquith, and Central Avenue streets. The number of houses inspected in this district was 281, containing a total of 1,515 inmates. All the houses in this district, with the exception of four where pump water is used, are supplied with water from the regular city supply. One hundred privies were found in bad condition. Only 33 are self-draining; the others are represented to be cleaned once or twice a year. Seventy-one houses are without cellars, while 76 were in bad condition, and quite a number contained filth and offensive fluids which could not be drained off. The portion of Asquith street embraced in this inspection presents an excellent example of the superiority of deep wells over shallow privy-pits. For instance, in 41 houses inspected, in this particular locality, all the privies that are not self-draining require to be emptied three or four times annually to prevent their getting into a state of nuisance, and even with this precaution they constantly emit noxious odors, while the deep wells were found generally clean and free from any decidedly bad smell. The latter, being self-draining, seldom require cleaning; but there are sanitary evils of very great gravity connected with the deep-well system, which will be hereafter fully considered.

THIRD DISTRICT.

Sixth ward.—Embracing portions of Orleans, Broadway, Bethel, Bond, Jefferson, Central Avenue, North Caroline, North Dallas, McEldry, North Eden, and North Spring streets. In this district 452 houses were inspected, containing a total of 2,382 inmates, or an average of about five persons to a house. The water supply is derived from the city works, except in fourteen instances, where pumps are used. One hundred and eight privies were found in bad condition, many of them overflowing and completely saturating the surrounding soil. Twenty-five of the entire number are self-draining, and all the rest require frequent cleaning, their usual depth being about 4 feet. In many cases they are close to or actually attached to the sides of the houses. Seventy-six houses inspected have no cellars, and in 56 of those having cellars they were found damp and filthy, and, in a few instances, flooded with stagnant fluids. Twenty-nine yards were in bad condition, a few very filthy, containing ashes, garbage, and house-refuse of every kind. In the case of 23 houses on Jefferson, Central Avenue, and Orleans streets, and in the case of 16 houses on Eden street, the Harford Run sewer passes through or very near the premises, creating a disgusting nuisance, revolting alike to decency and to health. In not a few instances this open, disease-engendering drain passes directly under the floors of houses, affording free entry of sewer gases into dwelling and sleeping apartments. The positive dangers of these gases cannot be overestimated, and the public mind cannot be too soon aroused to the fact that any one in the neighborhood of this filthy drain may be the next victim to the effects of its poisonous emanations. It is not only a possible, but a very probable, source of danger, which should be removed without delay. A large appropriation has already been made by the city for the purpose of arching, covering, and diverting this stream at specified points, and now no delay should be permitted in the accomplishment of a work which is of the highest sanitary importance. The remarks made on this subject in my last report to the State board of health may be with propriety repeated here: "In many respects Jones's Falls and Harford Run bear the same relation to Baltimore that Bayou Gayoso does to Memphis; and unless their sanitary condition is improved, they may, at no distant day, excite a malignant fever in our midst which will sweep off thousands of citizens, and, for the time, paralyze the whole business of the city. As long as the accumulation of filth in those streams is covered by water no injurious consequences will probably result; but should the quantity of filth be increased so as to rise above the surface of the water, the most dreadful consequences may be anticipated."

FOURTH DISTRICT.

Sixth and Seventh wards—Embracing 350 houses on Central Avenue, Monument, Milliman, Spring, Caroline, Dallas, Walker, Boundary Avenue, McEldry, Joppa, and North Bethel streets, with a total population of about 2,500 human beings. Ninety per cent. of the houses inspected in this district had shallow privy-vaults, not more than 5 feet

in depth as an average, and located some in proximity to and others from 1 to 10 feet distant from the dwellings. Fifty per cent. of these vaults were in bad condition, and many were full to overflowing, while nearly all needed cleaning; most of them emitted offensive smells, and only one of the entire number was self-draining. There were stables and manure-pits on 14 premises, which were generally in bad sanitary condition, some of them draining into alleys and streets and upon adjacent property. A large majority of the houses in the district are supplied with water from the city water-works. About 75 houses were without cellars, while the remainder were provided with cellars, many of which were damp and dirty, and a few offensive to smell. In several instances privy-vaults existed in the cellars, and in one house, notably, the privy adjoined the house and poured its noxious gases through a window into a damp, dirty cellar, which was very offensive.

FIFTH DISTRICT.

Seventh ward.—Embracing portions of Caroline, Dallas, Bond, Broadway, Chew, Monument, Milliman, Eden, Spring, Madison, Miller, and James streets, and Somerset alley. Three hundred and fifty-six houses were inspected in this district, containing a total of 3,108 inmates. Nine families are supplied with water from pumps; the remainder are supplied from the city water-works. Of the privies 203 were found in bad condition, many of them being full and others overflowing. Thirty-seven are self-draining, and the rest *profess* to be cleaned once or twice a year. A large number of these privies drain or empty directly into Harford Run. Out of 23 houses inspected on Spring street, the Harford Run sewer may be said to bear the relation of a positive nuisance in 16 cases. It is a nuisance in the case of 8 houses out of 22 at one point on Caroline street, and 9 houses out of 10 between Nos. 129 and 147 Spring street. The condition of the cellars and yards in the vicinity of this sewer indicates clearly what must be its influence sooner or later upon the health of the neighborhoods through which it flows. Fifty-eight cellars were found damp and in bad condition in this district, and the dampness existing in those on Spring street is directly traceable to the proximity of Harford Run. One cellar was not only damp, but actually flooded with foul water from this source. At one point on Spring street there is also a tannery, which emits a noisome smell, and its vats empty their contents directly into the run, adding another element of filth to its already black and offensive flow.

The character of a very large proportion of the diseases which have prevailed in this district indicates that the condition of Harford Run has already begun to influence in a very marked degree the health of those subjected to its seething and poisonous exhalations. This badly constructed and disgracefully filthy drain is undoubtedly the principal cause of a majority of the cases of sickness reported, and however energetic our State and city health departments may be in the performance of their respective duties, they cannot begin to enforce the requisite amount of sanitation to protect the public from these insidious and ever-pervading poisons. Their means are limited, and in the case of the State board of health their power is simply advisory.

SIXTH DISTRICT.

Eleventh ward.—The sanitary survey of a portion of this ward, which is situated in the higher and better part of the city, and contains, generally, only dwellings of the better class, embraced 118 houses, containing a total of 733 inmates, or an average of about six persons to a house. The cellars, yards, &c., of all these houses were found in good condition; water-closets in nearly every house, which are emptied by trapped soil-pipes into a well in the yard. Sixty-four of these wells are self-draining; the remainder are cleaned as often as may be required. The supply of water in every house is derived from the city water-works.

SEVENTH DISTRICT.

Eighteenth and Nineteenth wards.—Parts of each of these two wards were inspected, but as there was nothing of special interest in a sanitary point of view observed, it is not deemed necessary to enter into a detailed account of the inspection. As in the sixth district, a very large proportion of the privies are self-draining and for the most part exceptionally clean, as were also the cellars and yards.

Notwithstanding the fact that the privy-vaults in this and other high-lying districts are usually self-draining and very generally in excellent condition, the great importance of avoiding all sources of unwholesome and offensive effluvia, and of preserving the substrata of the city in a dry and clean condition, creates a severe necessity for relinquishing altogether these cess-pools, which can only be done by establishing a proper system of sewerage.

OVERCROWDED HOUSES.

Apart from the general conclusions to which we are led by the data from the several districts referred to above, even the partial inspection which has been made shows the existence of several serious evils in this community: prominent among them is that of overcrowded dwellings. Happily this evil has not yet attained the proportions in Baltimore which it has reached in other cities, but from the following instances it will readily be perceived that a foundation, at least, for the tenement-house system has already been laid in our midst. No. 73 Lancaster street is reported as being occupied by five families of 19 persons; No. 75, same street, contains five families of 18 persons; No. 100 Thames street, only 28 by 60 feet, with lot 28 by 30 feet, is occupied by five families of 34 persons; No. 128 Thames street contains three families of 16 persons; No. 253 Ann street, house 20 by 60 feet, has six families of 24 persons; No. 269 Ann street, house 18 by 70 feet, has six families of 37 persons; No. 290, same street, has five families of 18 persons.

Quite a number of other instances of overcrowding were noticed, and it seems probable that a thorough inspection of the whole city would reveal many more. The importance of securing comfortable and commodious accommodations for our laboring classes can scarcely be overestimated, but after the tenement system has once been fastened upon a large community, it is not an easy matter to sweep it away. Where it already exists to a large extent, as in New York, it can only be gotten rid of by long and patient effort; but there would seem to be no good reason why, in the case of a city like Baltimore, where the evil is still in its incipiency, it should not be forestalled by the efforts of an enlightened public spirit and philanthropy. Such an evil is as apalling in its moral as in its physical aspects. There is a fixed relation between comfort and morality. The man who comes home tired and exhausted wants quiet and comfort; if he finds filth, squalor, and discomfort in every shape around him, he naturally gets away from them and seeks selfish gratifications in the beer-shop, the brothel, or wherever they may be found. Virtue and vice are as dependent upon physical conditions as health and disease. "In these wretched dwellings," writes John Kay, of the tenement houses of London, "all ages and sexes—fathers and daughters, mothers and sons, grown up brothers and sisters, stranger adults—males and females—and swarms of children; the sick, the dying and the dead are huddled together with a proximity and mutual pressure which brutes would resist; where it is physically impossible to preserve the ordinary decencies of life, where all sense of propriety and self-respect must be lost, to be replaced only by a recklessness of demeanor which necessarily result from vitiated minds."

Conceive the morality of those who are "cribbed, cabined, and confined," all the grades of low humanity together, as occurs in some of the dwellings on Thames, Lancaster, and Ann streets, in Baltimore. In one small house, with a superficial area of only 18 by 70 feet, thirty-seven men, women, and children are huddled together in misery and squalor! Under such circumstances, health not less than virtue is impossible. What says George Godwin, a philantropist who has seen as much of the horrors of town shadows as most men? "Again and again would we assert that as you lead men and women to appreciate cleanliness, light, air, and order, you make them better citizens, increase their self-respect, and elevate them in the social scale. By the miserable dwellings to which thousands in our great cities are condemned we are impelling them downward—an easy process—with frightful results. *It cannot be too often repeated that the health and morals of the people are regulated by their dwellings.*"

THE COST OF SICKNESS AND DEATH.

It is no very difficult thing to prove that every death caused by the want of proper social measures must be a loss to the community, and that all unnecessary sickness, requiring the expenditure of money to cure it, must also be a loss; pauperism, we know, is often increased by the untimely death of those who support families, and, as a consequence, there is an increased expenditure of the public money. It is not because there is a difficulty in proving these truths that their influence has been so little marked, but it is because men have so rarely thought of them. Let it be remembered that a sickly population is one of the most costly burdens of a state. "Health is a poor man's capital in trade, and whatever deteriorates that entails a direct loss and eventually a heavy money charge upon the community." The enormous amount of poverty in this country, as in most of the European countries, and the consequent necessity of expending millions of dollars annually for its relief, are in a great measure due to the pauperizing effects of preventable diseases. It has been stated that the money lost through yellow fever alone, by the city of New Orleans, during the epidemic of 1878, was nearly \$20,000,000. To this add the loss sustained by other communities from the same epidemic, estimated at \$175,000,000, and say whether the amount is not worth trying to save.

NEGLECT OF SANITARY LAWS.

A glance at the condition of affairs in the several districts inspected shows an alarming degree of indifference or negligence in the observance of sanitary laws in the city of Baltimore; and especially would this seem to be the case with reference to the empyting and purifying of privies. In the older parts of the city the primitive privy is almost universally used, and only in a few instances are they self-draining; they are generally simply a shallow pit from 4 to 6 feet in depth, which, in many instances, has to serve the purposes of from 10 to 20 persons. A moderate regard for health and cleanliness would suggest the emptying of these places at least three times a year, but as a general rule they are emptied only once or twice annually. The result, as already shown, is that they very often overflow, saturating the surrounding ground with their disease-breeding contents, and probably sowing the seeds of some terrible epidemic. The danger involved in this state of things is heightened by the fact that these privies have, in many cases, been in use for many years, and the earth around and beneath them has become so saturated with their foul contents that it no longer has any power or virtue as a deodorizing or disinfecting agent. They can, therefore, only be regarded as store-houses of disease, and the sooner they are superseded by an enlightened system of sewerage the better it will be for the future health of the city.

PROVISIONS OF THE CITY CODE.

The Baltimore City Code, article 23, section 79, provides that "all privies that are liable or likely to get into a state of nuisance between the 1st day of June and the 1st day of October shall be well cleaned between the 1st day of October and the 1st day of June, and it shall be the duty of the board of health to cause to be made, through the commissioners of police and the force under them, between the 1st and 10th of each June, a thorough inspection of all privies, wells, or vaults within the city, and all that then may be found to be full, or within 18 inches therefrom, shall be deemed in a state of nuisance, and the owner or owners, agent or agents of the property to which the privy or privies respectively may belong shall forfeit and pay $20."

Section 75 clothes the city board of health with full authority "in all matters relating to the opening and cleaning of privies and vaults;" and section 84 provides that "if any person or persons shall erect, or cause to be erected, any privy or other building over any wharf or wall, or over the bed of Jones' Falls, or Harford, Shroeder's, or Chatsworth Runs, or suffer the contents of any privy to flow into the aforesaid streams, by means of a sewer or otherwise, within the limits of the city, so that the filth therefrom be discharged into the said falls, or either of said runs, such person or persons shall forfeit and pay, for each and every such offense, the sum of $20."

As is quite evident from the facts already given, these provisions are not very strictly enforced; indeed, it would seem to be impossible for the board of health, with their present facilities, to keep that watch and ward over the matter that the law contemplates. To require the police to make the inspections spoken of is prateially to nullify this provision of the code. The members of the force have already to play the part of men of all work, and to carry out this system of inspection properly would require an independent corps of assistants to inspect, not once a year, but quarterly, every privy, and report their condition to the health department. There is a crying and imperative demand for reform in this matter.

A SANITARY PARADOX.

Generally throughout the city pumps have been discarded, and the safer water supply by the city has been substituted. But there are still many instances in which pump water is used for drinking and domestic purposes. In the first district, second ward, pump water is used on from 130 to 200 premises, and the comparative immunity of the people from disease, under the most trying sanitary conditions, is extremely remarkable, but should not lead to the conclusion that filth and bad water are conducive to health. Several instances of remarkable health under the worst sanitary conditions possible may be mentioned in this connection. House No. 60 Philpot street, 20 by 50 feet area, contained seven families of 18 persons; the privy and premises, generally, were in very bad condition, and the supply of water was drawn from an old pump, but in spite of these facts no sickness or death had occurred among the inmates for more than twelve months. No. 51 Thames street, eight families of 29 persons, cellar damp, sewer closed up, forming a cess-pool with offensive smell, privy in filthy condition, water supply good. No sickness during the year. No. 103 Lancaster street, four families of 16 persons, house 15 by 18, no cellar, privy in bad condition, pump water used, said to be "bad;" the only case of sickness during the year was a case of consumption. No. 115 Lancaster street, three families, 9 persons, pump water represented to be "very bad," but the only case of sickness reported was a single case of consumption.

Many other examples of the same character might be cited, which go to show how much the human constitution is often capable of enduring, when subjected to influences capable of producing sickness and death. But no one can doubt that should some sudden epidemic spring up in the city, those unfavorable sanitary conditions would be terrible and fatal helpers of its progress.

DANGERS OF PUMP WATER.

One of the most dangerous characteristics of pump water in cities is that often when thoroughly contaminated with the noxious drainage from adjacent privies it fails to show any sign of contamination and apparently maintains its original purity unimpaired. The mere fact, however, that it has no bad taste and retains a sparkling and clear appearance is no evidence of positive purity. Even a chemical analysis will not always discover the true character of water, and we have the authority of Mr. John Simon, formerly chief medical officer of the privy council of England, for saying that the findings of chemical tests are not entitled to unlimited confidence. "Chemical demonstration of unstable nitrogenous compounds in water," he says, "is a warning which, of course, should never be disregarded; but till chemistry shall have learned to identity the morbific elements themselves, its competence to declare them absent in any given case must evidently be judged incomplete, and waters which chemical analysis would probably not condemn may certainly be carrying in them very fatal seeds of infection." The only safe course, therefore, in large cities would seem to be total abstinence from pump water, about the safety of which there must always be, at least, a doubt in such cases. Perhaps it is worthy of consideration whether cities might not properly and legally, in the exercise of their powers for the protection of the public health, prohibit the use of pumps absolutely, whether they be on the public thoroughfares or on private property.

NEGLECT OF SANITARY MEASURES.

In the second district, where the typho-malarial endemic of 1876 prevailed with such frightful fatality, pump water is still used by many families; and open cess-pits, so constructed that their contents drain into and ooze through the soil, continue to be the only depositories for excretal sewage, the volatile products of which engender influences most prejudicial to health; while the "slops" or refuse water from domestic operations flow into and pollute the gutters. The same condition of things, in a more or less marked degree, may be said to exist in other sections of the city, and it is no less surprising than alarming that the public fail to be impressed with the gravity of these evils. While a disease with its dread horrors is still fresh in our minds, the importance of careful attention to hygienic and sanitary measures must be considered a public and private duty. It is a recorded fact that large cities in which fatal epidemics have raged, have been those whose sanitary requirements have been badly neglected. "The presence," says the report of the general board of health of England on "the sewage and cleaning of towns," "of impurity produced by the decomposition of animal and vegetable matter, is now established as a constant concomitant of the excessive ravages of typhus and other epidemic diseases in towns; and a proportionate exemption from such maladies has marked the removal of the sources of aerial pollutions."

It is scarcely necessary to enter into the details of the connection between defective sewerage and the propagation of disease. It is now universally admitted that the exhalations arising from putrescent matter of badly-arranged and badly-constructed cess-pools and open privies are fruitful sources of disease. Indeed, the immediate and direct cause of yellow fever may be said to be the poison generated by the decomposition of animal and vegetable matters to which a specific germ is added. The experience of every medical man goes to prove that a badly cleansed and drained district is always a fever one. A competent witness has said that, "in addition to a general disarrangement of health and an unusual liability to disease, there is one particular class of diseases which is always to be found in neglected places, viz, the class of contagious disorders." History teaches us that pestilence has always haunted the scenes of filth. The plague, the black death, the cholera, the camp, jail, and ship fevers, all have made these scenes their favorite resorts, and yellow fever, our modern pestilence, forms no exception to the rule.

Another point of importance in connection with cess-pools and open privies, with saturated soil, &c., surrounding them, is of great importance as bearing upon the supply of pure air to houses; for it is easy to perceive that, however well ventilated the apartments may be, the appliances are rendered futile from the admission of air tainted by the admixture of gases emanating from the filthy accumulations of the cess-pools and privies. There can be no doubt that the public health may be, and often is, impaired by this cause, and it is one of the sources of disease which it is absolutely necessary to remove before there can be any effectual cure. In some of the houses

examined we have seen that the cess-pools are in the cellars, and give out their exhalations from thence; others are in the yard close to a door or window, through which the noxious air is introduced throughout the whole of the house. To meet the evils of the cess-pools and privies in Baltimore, a system of sewerage is absolutely required, and instead of the connection between the water-closets and drains being optional, it should be made imperative.

PART II.

In connection with the details already given, it may not be amiss to consider generally other important sanitary problems which bear upon the future health and commercial prosperity of Baltimore.

LOCATION AND TOPOGRAPHY.

The city of Baltimore is situated on an arm of the Chesapeake Bay, into which the Patapsco River flows. The tide in its harbor has a mean range of one foot and three-tenths, and produces scarcely any movement in its waters. Two prongs of this arm extend in a northwesterly direction. One receives the stream called Jones's Falls, having a flow, at low stages, of 15,000,000 gallons daily, and which passes through the center of the city. This prong, the upper end of which is called "the Basin," and the lower end "the Harbor," affords the port for nearly the entire commerce of the city. The other prong, lying farther west, receives the stream called Gwynn's Falls, having a dry-weather flow of 10,000,000 gallons daily. This stream may be considered the natural western boundary of the city. Another stream called Herring Run, nearly equal in volume to the last, flows in a southeasterly direction, and discharges into another arm of Chesapeake Bay to the east, called Black River. This stream may be considered the natural eastern boundary of the city.

Between these two prongs is inclosed a peninsula with two points—the eastern one being the site of Fort McHenry, the other that of a bridge crossing into Anne Arundel County on the south. It joins the mainland with a maximum elevation, across the neck, of 35 feet above tide, and reaches an elevation of 90 feet in the interior. Having a shore more or less bold along its entire margin, it becomes very abrupt at "Federal Hill," at the upper end of the harbor. This district is known as South Baltimore and forms the southern limit of the city.

Lying upon the west side of the central stream, and extending about half a mile above the water front on the Basin, is an area of about 75 acres elevated not more than 10 feet above tide. This is called the "flooded district," from its having been on several occasions overflowed by the drainage from the back country during extraordinary storms; notably in 1868, when 20,000,000 cubic feet of water occupied the streets and residences of this densely populated section. From the margin of the "flooded district" the ground rises rapidly upon each side, reaching an elevation of 100 feet in a quarter of a mile on the west, and of 50 feet in the same distance on the east. Above this, along the whole course of the stream, the banks rise abruptly on each side.

On the north side of the harbor, lying between it and the Philadelphia Railroad, is an area of about 125 acres, the elevation of which is less than 6 feet above tide. It embraces the "City Dock," a pool 300 feet wide and 1,800 feet long, into which Jones's Falls has been conducted. It also receives Harford Run, the next largest stream which passes through the city. In dry weather both these streams, which have been converted by bad management into open sewers, are intensely charged with effete products of the population; and for which the dock acts as a catch-basin. This area embraces "District No. 1," already described in the first part of this report, and generally known as the typho-malarial district. As already stated, many of the residents in this district depend upon pumps in the neighborhood for their water supply, and cases of overcrowding in very old buildings have also been noted. The extent of the latter evil, heretofore commented upon, is thus described in the Sunday News of June 20, 1880:

"The people of what is called by some the malarial district are becoming more and more alarmed at the overcrowding of some of the old houses in southeast Baltimore by impoverished emigrants, the majority of whom are Bohemians. On Aliceanna street, between Wolf and Ann streets, is an old building (the square is known as Bohemian Row) which has a front of 30 and a depth of 100 feet, and is two stories in height. It was about half a century ago used as a private dwelling. It has now been cut up into twenty small compartments, into which, at present, no less than sixty-eight human beings—men, women, and children—are indiscriminately huddled. The sight of the barefooted women, the ragged men, the half-naked children attracts the attention of all passers. This week two children died in this hive, and others are sick. The stench from the place is sickening in the extreme, and the only fresh air the inmates enjoy is that which they get by crowding out in the side yard, as they are ashamed to appear on the street in their half-nakedness or ragged habiliments."

On the western boundary of the city, at the head of the other prong, is a cove of nearly 100 hundred acres in extent, into which Gwynn's Falls discharges. The sediment from this stream has nearly filled up the cove and converted the greater part of it into a marsh, leaving the remainder covered by a shallow stratum of stagnant water, bordered next to the city with a strip of low ground in a high state of cultivation. In this direction the ground immediately rises to an elevation of 16 feet along the line of the Baltimore and Ohio Railroad, and reaches 60 feet at Mount Clare, a half mile to the northwest, and gradually rises to an elevation of 230 feet in the extreme northwestern section of the city. On the opposite side the ground rises rapidly from the marsh; and below the cove the shore of the estuary continues with high ground and deep water throughout. Toward the north the course of Gwynn's Falls and its branches lies between steep hills. With the exception of the low areas just described, the ground rises everywhere with sufficient rapidity for the most perfect drainage.

GEOLOGICAL FORMATION.

With the exception of a ledge of gneiss rock which intrudes over a small area on each side of Jones's Falls, near the northern city limit, the whole of Baltimore stands upon a deposit of clay, sand, and gravel, sometimes alternating with each other, but with the coarser materials predominating at the base. Over a large extent, and on the highest elevations, a thick stratum of clean sand lies near the surface; while some of the lower outlying portions have at the surface a stratum of pure clay, the same which furnishes the famous Baltimore brick. At the base of all is a stratum of water-flowing gravel. This gravel is met with everywhere below the bed of Jones's Falls and at the bottom of the harbor along the water front. Beneath this is a thick and continuous stratum of tough, impervious clay, extending under the harbor, which the well-diggers designate as the "river bottom."

DRAINAGE.

In the western section of the city a stream called Schröder's Run originates at an elevation of 160 feet, in the neighborhood of the Cathedral Cemetery, and flowing southwest for two miles enters "Ridgley's Cove," just east of the marshy cove above described. Opposite to this, and draining from the same neighborhood, another stream three-quarters of a mile long, discharges into Jones's Falls at the northern corporate line of the city.

At a half mile toward the east, and upon ground of the same elevation as the former, in the neighborhood of Entaw Place, a stream called Chatsworth Run gathers the drainage and, flowing in the same direction for a mile and three-quarters, joins Schröder's Run just before reaching Ridgley's Cove. Draining from the same area in the opposite direction a stream a half mile long discharges into Jones's Falls nearly a half mile below the former one on this side.

Two other streams originate, at an elevation of 100 feet, in the neighborhood of the present Johns Hopkins University buildings; one, taking the course of Tyson, Liberty, and Howard streets, flows down upon the neck, where commences the peninsula of South Baltimore, and across which it has been conducted by a sewer along South Howard street and discharged into Ridgley's Cove, near the entrance of Schröder's Run. Its counterpart flows due east along Centre street, and discharges into Jones's Falls at the upper end of the "flooded district."

Another small stream gathers on Federal Hill, in South Baltimore, at an elevation of 75 feet, and flowing southwest for nearly a half mile discharges into Ridgley's Cove near the Howard-street sewer.

All these streams originate in and flow through fully-occupied sections of the city, and they are, in part, conducted through sewers of an irregular character. The two largest, Schröder's Run and Chatsworth Run, before reaching Ridgley's Cove flow in their ancient and natural beds for nearly a mile, and during warm, dry weather the water which they contain is usually black and reeking with noxious gases. The unoccupied portions of the western section of the city drain into a stream called Little Gwynn's Falls, which gathers in the neighborhood of Hookstown, a suburban village, two and a half miles northwest of the city limits, and enters Gwynn's Falls proper a mile above the cove. This is an exceedingly filthy stream.

In the eastern section (*i. e.*, east of Jones's Falls) the first stream within the present corporate limits is "Jenkins's Run," which originates at the northern limits of the village of Waverly, more than a mile from the city, at an elevation of 200 feet, after draining, with several branches, a thickly-populated suburban district, in which are many slaughter-houses, distilleries, hair-factories, tanneries, and other foul establishments, it passes for a half mile through the city and discharges into Jones's Falls near the western portal of the tunnel of the Union Railroad, where that road joins with the Northern Central Railroad. Within the city it passes through a sewer 12 by 18 feet

diameter at the upper end, which sewer is reduced at the lower end, before it enters Jones's Falls, to a diameter of 7 by 7 feet.

The next drain is a small stream which gathers on Gallows Hill at an elevation of 120 feet, and flows through a sewer along McKim and Monument streets to Jones's Falls, where it discharges.

HARFORD RUN.

The third stream is Harford Run, which drains from "Clifton," the future site of the Johns Hopkins University, at an elevation of 200 feet, and a half mile beyond the city limits. After crossing the Union Railroad at Belair avenue it passes through a series of irregular sewers and drains, through yards, and under houses, to Central avenue, along which it is conducted by a regular sewer to the city dock. This irregular part of the sewerage of Harford Run nearly describes a circular arc, of which the Johns Hopkins Hospital, standing at an elevation of 110 feet and a quarter of a mile distant to the east, is the center. From the city limits to the dock the course of this stream is two and three-quarter miles. Its filthy condition has been a subject of public criticism for many years past, and the evil finally became so intolerable that the city council was induced last year to make an appropriation to improve the condition of the stream by changing its course and arching it throughout. The work is now in progress, but as it is not laid out in conformity with any plan for the future sewerage of the city, we may well believe that, except for temporary purposes, it will be a fruitless expenditure of money. In referring to this matter the Baltimore American of the 23d of July, 1880, thus forcibly speaks:

"Sooner or later Baltimore must have a thorough system of underground sewerage and drainage. The trouble, losses, and suffering that have been occasioned in the northeastern section by the overflowing of Harford Run by an ordinary summer rainfall emphasize the necessity of a comprehensive and systematic plan. Scores of families of poor people have had their homes undermined, their furniture injured, and the daily occupations upon which they depend for their bread and meat interrupted, because the municipal government has for twenty years been trifling with the nuisance of a slow-moving stream of filth, and has just resolved to endure it no longer. If the Harford Run sewer is not constructed with more engineering skill than was displayed in that on Liberty street, a great deal of money will again be expended without producing the proper results. The beginning of it proved on Tuesday a remarkably efficient aid in backing water into all the cellars in the neighborhood."

Another stream, called "Harris's Creek," drains from the neighborhood of the Baltimore Cemetery at an elevation of 175 feet, and flows south along the eastern outskirts of the city, where there have recently been erected blocks of new and clean residences. This stream enters the harbor immediately opposite Locust Point, the marine terminus of the Baltimore and Ohio Railroad, having had a course of two miles. The lower end of the stream, for nearly a half mile, formed a tidal inlet three or four hundred feet wide; but it has been nearly filled up with oyster-shells from the packing establishments and waste products of factories, furnaces, and residences. East of Harris's Creek at this point the ground rises immediately, and reaches an elevation of 125 feet at Highlandtown, a half mile distant. The lands of the Canton Company continue in this direction far beyond the city limits, preserving to the water's edge the most favorable conditions for drainage.

JONES'S FALLS.

In a sanitary point of view this stream may be said to be the *bête noire* of Baltimore, and has long engaged the anxious attention of the municipal government. Outside of the city, on the north, it receives the drainage of a large scattered population, and of the villages of Hamden, Woodbury, Waverly, and part of Govanstown, while the areas of greatest population in the city drain directly into the stream, and, as the city becomes extended, this will be increased in a still greater proportion. The evils arising from this state of affairs cannot be much longer endured, as public apathy on this important question of sanitation amounts really to a public crime. The following from the American of June 27, 1880, is not only a faithful picture but a just criticism of the nuisance:

"Jones's Falls cannot by any possibility be anything but a nuisance. Twice in the last half century it has overflowed its banks and inundated the sections of the city along its course, causing a vast deal of damage and knocking 50 per cent. off the value of contiguous property. The city has spent several hundreds of thousands of dollars to make such improvements that any freshet in the future will be confined within the retaining walls and the volume of water will not escape over them into the streets. But a flood is only a matter of occurrence only a few times in a century, while the nuisance of the falls as a malodorous cess-pool is with us every year. Just now it is at its worst. For several weeks past there has not been a strong enough wind from the north to drive out its stagnant waters, and the tides have simply acted to back them up between the basin and the Madison street bridge. As a consequence the

falls is rotten and nauseous with filth. The hot sun brings out from the still and polluted waters a terrible stench, just as it breeds maggots in carrion. The atmosphere in the neighborhood of the bridges is so poisoned with the malaria that a healthy man's stomach is turned by breathing it. From the surface of the water the mephitic gases may at any time be seen coming up in bubbles, and the stench seems to be the very essence of putrefaction. It must inevitably be a source of disease and death, especially as it pervades the atmosphere of the thickly-populated regions of Old Town and East Baltimore. A very heavy rainfall or a succession of northerly winds for several days would clean it out, but there is no certainty that nature will soon apply any purifying process, and meanwhile the falls goes on to help breeding a pestilence. If the water department has any water to spare, it cannot be put to better use than in flushing out the falls. The mass of stagnant filth ought to be removed; and if that is not done, the increase of the weekly death-roll will bear testimony that we have an uncontrollable nuisance in the heart of the city."

Were it not that the bed of this stream is required to give passage to the immense volumes of water which drains from a large extent of back country when a sudden storm breaks upon it, it could be converted into the main sewer of the city for its surface drainage. Lying as it does at the base of all drainage, and supplied as it is with a permanent stream of water, and capable of being flushed to any desired extent, it could also, economically and effectually, be made to serve as a final receptacle and conduit for a system of sanitation sewerage, for it could advantageously be continued to any distant point of discharge. Whatever system may be employed, the character and necessity of this conduit of distant discharge remains the same; it must lie at a low level, and be assisted by steam-power. Were this main sewer rendered practicable by the diversion of the floods from the back country, the loathsome sight of Jones's Falls, with its inconvenient and expensive bridges*, would be abolished, while a large and valuable space in the heart of the city would become available for building or other useful purposes.

That this measure is eminently practicable can hardly admit of a doubt. It is a subject which received the earnest consideration of the first engineer, Latrobe, grandfather to the present mayor of Baltimore. He recommended the diversion of the excess of water of Jones's Falls into Herring Run by means of a tunnel under Gallows Hill upon a line which nearly coincides with the present tunnel of the Union Railroad and thence by a canal to Herring Run. This plan could not now be carried out without interfering with the railroad system that has since been developed, and with a large and growing section of the city on the east. Moreover, it would be highly desirable that the advantage of such an improvement should extend as far as the probable future limits of the city.

Just where a northern limit line was established by the legislature of Maryland in 1874, and beyond the village of Woodbury, the bed of Jones's Falls lies in the same direction as that of Gwynn's Falls, where the Franklin road first comes alongside of it. The distance between these two points, about 3 miles, is nearly the shortest between the two streams; and the difference of elevation between their beds, about 5[illegible] feet, admits of an inclination of a water-way connecting these points sufficient to impart to the waters of Jones's Falls thus diverted a velocity of more than 10 miles per hour. The base of the intervening hill is an uninterrupted mass of gneiss rock, and its surface would be generally elevated 150 feet above the tunnel perforating it. It is estimated by Major Randolph that if such a tunnel had a width of 50 feet with a semi-elliptical roof 40 feet above the floor in the middle, it would pass a much larger quantity of water than that which passed the arch at Eager street bridge during the unprecedented flood of 1868. The stone derived from the excavation of the tunnel would be perfectly suitable for the construction of the proposed grand sewer of Jones's Falls to replace the present open stream, which could be made of sufficient capacity to pass the volume of ordinary storms independent of diversion, and easily accessible at low water to carts or cars for the removal of deposits or obstructions, &c. The dam can be constructed across the narrow rocky valley in such a manner as to be beyond the possibility of breaking; and the tunnel would at least be as free from the contingency of choking as the arch at Eager street bridge.† Such a diversion would probably necessitate an increase in the span of several bridges across Gwynn's Falls; and a few strips of low ground which border it might possibly be more deeply flooded than usual when a rise in both streams occurred. But the necessary increase of damage along this deep valley, as improvements now stand or are likely ever to be made, would be but trifling. The cost of this diversion, without taking into consideration the value of the space reclaimed, has been estimated at $3,000,000.

*Jones's Falls, from Boundary avenue to the city dock, a distance of not more than 3 miles, is spanned by not less than sixteen bridges, some of which have recently been erected at an enormous cost to the city. The city of London, with a population of 4,000,000, is traversed in its most densely populated sections by the river Thames for a distance of 12 or 15 miles, and it has only been found necessary in that great city to erect ten bridges and a single tunnel. The river Seine passes through the most populous part of Paris for a distance of 8 or 10 miles; it is only spanned by twelve or fourteen bridges.

†This diversion scheme was urged by me in a report made, as chairman of the joint standing committee on health, to the city council of 1873

WATER SUPPLY.

Five miles from the northern corporate limit the waters of Jones's Falls are collected for the use of the city, at an elevation of 225 feet, and are delivered through a conduit of 25,000,000 gallons capacity into the distributing reservoir in Druid Hill Park, at an elevation of 220 feet, from which it is pumped by steam-power into a higher one in the park, at an elevation of 325 feet. Beyond the dam the drainage territory which supplies the lake supports a large rural population, and embraces the summer residences of a large number of the more wealthy citizens of Baltimore City.

On a few occasions in the history of the present supply it has only amounted to one-third of the capacity of the conduit. As a supplement to this, on such emergencies, steam pumping engines have been located upon the Gunpowder River, about 6 miles distant from the dam. They force the water through a pair of pipes to the top of the intervening ridge, from whence it flows into the lake, thus increasing the supply with 10,000,000 gallons daily.

In another year the works for the new supply will be completed. This will draw the water from the Gunpowder River 4 miles below the present pumping engines, to which point the dam will back up the water, and conduct it through a tunnel 7 miles long, and of a capacity of 160,000,000 gallons daily, with reservoirs on Montebello and Clifton, having an elevation of 165 feet. This quantity is the volume of the river at its ordinary low stages, and can be supplied by gravity to all those districts lying below an elevation of 100 feet above tide. Naturally this water is of uncommon purity and softness, and at present comparatively free from contamination. It is stated that on one occasion a measurement showed that the river only supplied about one-third of the capacity of the conduit. This proportion of one-third supply at periods of extreme drought in both the new and old supply coincides with the case of the Croton supply for the city of New York. As in the case of the Croton River, the valley of the Gunpowder offers numerous and highly favorable situations for an indefinite and superabundant amount of storage, a system which is very conducive to the purity of the water. Thus it appears that for the present and for the future Baltimore has extraordinary advantages in her water supply.

THE BASIN.

The emanations from a thousand alleys and gutters and from sixty or seventy thousand privy-vaults, the leaky pipes of three gas companies, the manufacturing of soap and agricultural fertilizers, and the slaughtering of thousands of animals, with a great variety of other malodorous operations carried on within the city, supplies the atmosphere of Baltimore with a number of smells equal to that of the city of Cologne. But the odor which emanates from the basin, the city dock, and the tidal range of Jones's Falls during the dry spells of summer is one of the monuments of the "Monumental City." In Schröder's Run and Harford Run this offensive condition is generally present during warm weather in one or two days after a rain. In Jones's Falls it begins in about a week after a copious flushing. In the large body of water constituting the basin the time is modified by the direction of the wind and the concurrence of extraordinary tides. When the wind prevails from the southeast the discharge from the city dock is wafted into the basin. When it blows from the northwest this foul fluid is scattered and commingled through the wide expanse of the lower harbor, and the surface-water of the basin itself is driven out and scattered before the sun has fully induced the chemical action. But at all places in Baltimore and in all cities the effects of polluted water subject to the heat of summer is the same; it becomes black and bubbling, evolves sulphureted hydrogen and other noxious gases, and gives a dark hue to white paint.

It frequently happens that immense numbers of fish enter the basin when the water is in a state of comparative purity and remain there until Jones's Falls, the great generator of the foul and poisonous water, accumulates it in their rear, cutting off their retreat, and then the water in the entire basin gradually assumes the same condition, until it will no longer support animal life. On such occasions the fish are seen floating in thousands on the surface and loading the atmosphere with another noisome odor. It is well known that the pollution of the basin has been at times greatly increased by a violation of the law forbidding the emptying of night-soil into its waters by those engaged in cleaning privy-vaults. In the past few years this practice has been somewhat checked.

Dredging machines are now constantly employed in removing the black mud and slime which is always accumulating in the docks and along the pool of Jones's Falls. These foul sediments have been deposited at various points near the shore several miles below, where they have created similar nuisances in the neighborhood, and for which fines have been imposed upon the contractors by the legal authorities of Baltimore County. In one instance damages were awarded to the extent of $10,000.

In 1859 a commission appointed by the mayor and city council and headed by Henry Tyson, civil engineer, reported a plan for a system of sewers to be located along the

principal depressions and designed to carry the surface drainage to the nearest tide-water, in which occurs the following paragraph relating to the pollution of the basin: "In most European and American cities, the water-closets are allowed to discharge into the sewers. This plan, we think, may be advisable in cities located on the sea-coast, the harbors of which are swept by the tide, or upon the banks of large rivers with strong currents. To pursue this system with the city of Baltimore would turn its landlocked harbor (the basin) into a vast cess-pool and materially affect the health of the city during the summer months. The Thames at London has become so polluted with the increased size of the city that the English Government has now under consideration the propriety of conveying off the drainage to the sea, near the mouth of that river, by immense conduits. The plan for the accomplishment of this object by Messrs. Bazalgette & Haywood, it is estimated, will cost £3,000,000."* This report seems not to have recognized the fact that the basin was already a "cess-pool," and it ignored the fact that many thousand self-draining wells were then discharging into it.

In 1871, Engineers Craighill and Kneass, employed by another commission, reported a plan for the improvement of Jones's Falls, principally with a view of preventing overflow. In referring to the basin they make the following suggestions: "A good method of correcting to a great extent the filthiness of the basin is, to arrange near the outlet of each sewer a receptacle where the most corrupting elements may be caught, purified, and removed. Private sewers, emptying into the basin, should be strictly prohibited. The great sewers, after receiving the contents of the smaller, should be few in number when they reach the basin. It will be neither difficult nor expensive to prepare for each of these large sewers, in the dock in which its mouth shall be located, such a receptacle as has been referred to above, where the more solid matters may be collected and removed at suitable intervals." This report also ignores the existence of the subterranean flow from the bottom of the deep wells, and assumes that everything not solid or no heavier than the water in which it is finely suspended, may be allowed to escape into the basin with no evil consequence.

In 1873 Mr. Wm. J. McAlpine, civil engineer, employed by a commission appointed to devise means for purifying the basin, submitted a report in which the following occurs: "The substances causing these noxious exhalations are brought into the basin—first, by the present sewers; second, by superficial street drains; third, by garbage thrown into the basin; fourth, by the flood tides which carry the foregoing matters forward and deposit them in the basin." Mr. McAlpine, like the other engineers, has also ignored the effect of the self-draining wells in polluting the waters of the basin.

In February, 1876, Mayor Latrobe sent to the city council a special message in relation to the basin nuisance, in which he says:

"Summer after summer our city is assailed during the heated term with a most abominable stench, arising from what is now the receptacle of the filth of a great and rapidly growing city, emptied into it by our present system of surface and sewer drainage. With each succeeding year during this noxious period, the people cry aloud against a continuance of an evil that actually threatens the necessity of an abandonment of the immediate neighborhood of this 'pool,' or the lives of the whole community by aiding any migratory pestilence that might visit the city. This nuisance should certainly be abated, and whatever reasonable cost might be incurred would, if honestly and economically expended, be cheerfully met by the people.

"Either the smell of the basin must be cured, or the city of Baltimore will be driven from its shores. There is no other community that would in the present age of refinement and high civilization so long endure such a curable evil."

Mayor Latrobe, under date of September 11, 1876, in another message to the city council, takes occasion to remind that body again of the basin nuisance, and suggests the remedy of an intercepting sewer. His language is as follows:

"For many years past the city of Baltimore has used the basin as the common receptacle of all its sewage, notwithstanding the fact that summer after summer we were reminded by its disagreeable odor that this nuisance should be abated.

* * * * * * *

"It is certainly manifest that, independently altogether of the sugar refineries, if the city continues to annually discharge its constantly increasing drainage of filth and sewage into the almost tideless waters of the basin withoutco nstantly dredging it out again, the water must necessarily become polluted, and exhale noxious and offensive odors, constantly threatening the health of our citizens.

"Under these circumstances it becomes a matter for consideration whether the certain cure of any recurrence of that well-remembered 'stench,' without interference with our manufacturing or commercial interests, would not be the construction of the intercepting sewer recommended by the committee appointed by the city council in 1873, and provided for by the enabling act of the last session of the general assembly. If this is the remedy—and I believe that it is—it becomes a question for your honorable body to consider whether this is not a most favorable time for the commencement and prosecution of the work."

* This plan has since been carried into execution, and the actual cost was $5,000,000.

Again, in his annual message to the city council, January 1, 1879, Mayor Latrobe uses the following language in reference to the basin:

"During the winter months we are so free from the basin nuisance that, forgetting its offensive summer odors, we are led to believe that perhaps the basin at last has cured itself. The permanent abatement of the basin nuisance is, however, a subject to which the attention of the council should be earnestly directed. Many plans have been suggested, and public opinion seems to be divided upon the subject. For my own part, I have always believed in the necessity of preventing the basin from being made the receptacle of the filthy sewerage of the city, by the construction of an intercepting sewer, as is being done in Boston, with which the sewers already constructed, and those required hereafter, could be connected. Such a sewer would receive and carry off to some point on the river, where it would be swept away with the tide, all deleterious matter discharged from soap factories, sugar refineries, gutter drainage, &c., that now finds its way into the basin. There are others, however, who think the nuisance would be better abated by the adoption of a plan for flushing the basin with pure water, and thus cleansing it by dilution. The subject is one of importance, and the public will never be satisfied until the different plans have been submitted to scientific investigation. For this reason I suggest that power be given to the mayor to appoint a proper commission of three gentlemen with the requisite knowledge on such subjects, who shall make an investigation into the cause of the basin nuisance and suggest a plan for its cure. The expense attending such an investigation would be small, and the report would doubtless enable the city council to estimate the cost of what at no very distant day must be undertaken by the city."

We thus see that there is an accumulation of authority for saying that the basin, under existing circumstances, is a foul, disease-engendering cess-pool, and that the abatement of the nuisance is essential from every point of view. The whole question is manifestly one of difficulty, but it is one which deeply concerns all classes of the community. No class possesses an immunity from the evils which the neglect of the laws of sanitation bring into existence; all are subject to their influence. Hence the importance of the municipal authorities taking boldly hold of this question. The safety of the people should be the supreme law!

The plan of an intercepting sewer along the water front to connect with the present sewers, as well as those which may be constructed in the future, and conduct their flow to some point below the harbor, is undoubtedly the first and most important step towards abating this great nuisance, provided it is so constructed as to intercept the unperceived flow which now issues from the many thousand self-draining privies, through the gravelly base of the city, at every point along Jones's Falls, as well as the whole water front.

Many intelligent citizens of Baltimore have, apparently, satisfied themselves that the odors, or, as Mayor Latrobe aptly terms it, "the stench" of Jones's Falls and the basin are almost entirely due to the operation of refining sugar, with the discharge of the waste products into these receptacles. But it is an unquestionable fact that the existence of the stench preceded the establishment of the refineries, and has continued to a large extent since the abatement of the alleged nuisance. Thus, in February, 1855, Capt. Montgomery C. Meigs, United States Engineers, now Quartermaster-General of the United States Army, who was consulted, thus expressed his views in reference to an additional water-supply: "Every reason which would induce me to recommend a liberal supply of water for Washington applies with equal force to Baltimore, which, moreover, needs a larger quantity of water to purify the stagnant harbor, *whose odors during the last summer must be in the recollection of all its inhabitants, as they are with that of all who passed through the city by railroad.*" At this period the Calvert refinery, which is charged with all the evil, was not built, and the business of refining sugar in Baltimore was just commenced on a very small scale below the basin, where the operations have never been considered in this question.

So, too, although the refining operations have ceased since 1878, the old complaint has repeatedly appeared along the pool of Jones's Falls and in the basin during the past two summers, showing conclusively that the disagreeable odor is largely, if not entirely, independent of the sugar refineries, and can therefore be ascribed to no other cause than that of the putrescent matters which constantly flow into Jones's Falls and the basin from almost every section of the city.

"It is evident," says Mr. McAlpine, "that if the water in the basin was pure, and no offensive matter was allowed to come into it, and the semi-daily tidal inflow was pure sea-water, its waters would emit no unwholesome exhalations. The first step, therefore, is evidently to prevent the entrance of all sewage and matter from superficial street drains, and also, as far as possible, the defilement from the inflowing tide.

"Upon any plan of reparation of the basin, the diversion of the sewage and street washings must be first made, and then must be the prevention of the contamination of the inflowing sea-water from the same defilements. Hence follows the necessity of sewers of sufficient capacity to carry off all such matter, and discharge it far enough below the basin to prevent it being subsequently brought into it by the tidal flow."

PART III.

THE QUESTION OF SEWERAGE.

This subject has already been several times adverted to, but its importance demands still further notice. Although, for general health and exemption from epidemic diseases, Baltimore has hitherto occupied a very high rank among the cities of the world, there has never been inaugurated any general system of sanitary works, nor has there ever been authorized a thorough scientific study of its sanitary conditions, having in view the elimination of all obnoxious elements through the means afforded by modern science and skill. Under the temporary excitement occasioned by a destructive flood in the stream which traverses the oldest and densest section; by the overflowing of the insufficient water-ways provided for several drainage areas in other parts of the city; or by the prevalence of a foul atmosphere of extraordinary intensity and duration arising from the harbor and the streams flowing into it, spasmodic attempts have been made at the time to institute measures adequate for the suppression of the evils then apparent. But the subject has always been dropped with no other result than the display of a "multitude of counsel" and a great conflict of opinion. Several extensive schemes, involving large expenditures of money, have been on the point of realization, but have fortunately failed, as they were proposed without a thorough understanding of the whole subject with which the questions were necessarily connected, and seemed to be supported principally by the pecuniary interests involved in their execution.

The few existing sewers have been constructed entirely with a view of conducting the surface-drainage which accumulates along the principal depressions. In certain sections along Schroder's Run, Chatsworth Run, and Harford Run, they present the greatest variety of form and capacity, and follow crooked and oblique courses across the squares and under the houses, alternating with open drains, walled up with loose stones and sometimes covered with planks. They have been adapted to the exigencies, as they arose, of certain limited localities and periods, regardless of any general plan, or the requirements of other times or places. Although it is contrary to law to devolve upon the sewers the function of scavenger, yet its violation is seldom inquired into, or reprehended when coming to the notice of the authorities; while in many cases permits are granted for private drains of this character to connect with them. Still more frequently, both by accident and by design, the overflow from vaults and imperfect sinks reach them by way of yards, alleys, and street gutters. In many places, as has been stated, these receptacles were found "running over," an occurrence which is more frequent in hot weather, in consequence of the generation of the gases of decomposition. The water-way provided by these conduits is, in a number of instances, entirely insufficient for the passage of the volumes of water which reach them after a heavy fall of rain; and they have been repeatedly overflowed, scattering their foul admixtures over yards and into cellars and basement rooms. At all times during the summer they exhale an odor which is a public nuisance. In the western section of the city some of these insufficient conduits have been supplemented by regular sewers, following the line of streets to relieve them from floods, but without abolishing the old systems, which continue to perform their illegitimate office of house and vault drains. Several sewers have been constructed for the express purpose of draining certain public establishments. One of these sewers receives the sewage of the new city hall, and from two of the principal hotels, which is discharged into the docks along Pratt street.

But the almost universal practice of getting rid of excretal sewage is by the simple well, varying in depth from 3 to 75 feet, and walled up with dry brick-work. This system dates from the foundation of the city, and has been extended with the growth of the city. In the commercial section of the city, contiguous to the basin, these wells, although not exceeding 10 or 15 feet in depth, in many places have a free communication with the tide, which rises and falls within them through the intervening stratum of gravel. Thus their contents are constantly disintegrated and dissolved and discharged, finally, into the basin, a process which has been going on, in many cases, for half a century. In a district embraced by Charles, Baltimore, Pratt, and Harrison streets, 65 per cent. of these wells do not require artificial emptying; in another section embraced by Read, Calvert, Biddle, and Cathedral streets, for the most part elevated 100 feet above tide, 34 per cent. of the wells are self-draining, it being necessary for this result to carry them down to a depth of 40 or 50 feet. Another district embraced by Fremont, Franklin, Gilmer, and Lanvale streets, with an elevation of 150 feet, where deep wells are more general, 62 per cent. are self-draining. But in another district, mostly occupied by old and indifferent dwellings, included between Boundary, Fayette, Chew, Gay, and Asquith streets, and traversed by Harford Run, not more than 5 per cent. of the wells are self-draining, and these

are confined to certain blocks of new houses. The remainder of the wells in this district do not average a depth of more than 6 feet, and consequently require to be emptied three, four, or five times annually. It is safe to assume that one-third of the houses of Baltimore are now provided with deep or self-draining wells, but most of the water which is constantly discharged into them finds a slow exit and reaches the subterranean conduit afforded by the beds of gravel, and carry in solution the materials for future noxious exhalations. Many of these wells are confined to an impervious soil, and frequently, as has been seen, discharge over the surface into the street, or, what may be worse, they penetrate a sandy soil only to where a stratum of clay intervenes to arrest a downward flow; and here the noxious fluids permeate the sand in all directions near the surface and frequently issue into the foundations of houses. An instance of this sort can be cited in one of the most elegant neighborhoods in the city, having an elevation of 100 feet, with the surface sloping in all directions. Here the well is of insufficient depth and is located in the yard, which is 7 feet higher than the kitchen floor. Every few months the cook is disagreeably notified, by the water invading the kitchen, that the well needs attention. This, although a very prominent case, is doubtless an exceptional one in that immediate neighborhood. There are, however, sections of the city in which this condition of things is the rule, and no section is free from defective wells.

Referring to the cases of a porous soil permeated with such matters to the extent acquired by slow exudation and capillary attraction, we have very high authority for considering such conditions eminently insanitary. In his report on the sanitary condition of the city of London for the years 1866–'67, Dr. Letheby, health officer, in discussing the cholera epidemic of 1866, says: "The theory of Pettenkofer is that the essential conditions for the active manifestations of the disease are a porous soil charged with excrementitious matter and having a certain degree of hydration, as happens when the subsoil water is just drawn off or slowly retiring. All these conditions are singularly coincident with the localization of the disease in the eastern districts of London; for the soil is gravelly and therefore very porous to air and water, and is largely charged with excrementitious matters derived from the local tide-locked sewers. It is also remarkable that for some months before the outbreak of the disease the subsoil water had been gradually sinking in consequence of the drainage operations that were necessary for the construction of the main lower-level sewer and its branch to the Isle of Dogs. Now, according to Pettenkofer, it is exactly under these circumstances that a district is most liable to choleratic infection."

Here is the theory of the most celebrated sanitarian in Europe confirmed by the observations of the health officer of London; a theory which finds a direct application to a large portion of Baltimore, where "a porous soil charged with excrementitious matter having *a certain degree of hydration*" prevails in consequence of the slow percolation and absorption from the wells.

In every part of the city, high and low, among the rich as well as with the poor, there is an escape of noxious gases from these privy-wells, which becomes very much more disagreeable and apparent during the heat of summer; and the fluids escaping from kitchens and sculleries, not less harmful if less offensive, maintain perennial streams in all the gutters, and either directly or indirectly find their way into the harbor, which is the common receptacle for all the filth of the city as well as drainage of a large back country.

With regard to the self-draining wells, there are many who contend that the simple passage through strata of sand and gravel deprives the water of the deleterious matter which is held in fine suspension or in solution, and that this fluid finally issues into the harbor in a state of purity.

That these fluids are not filtered of their impurities is conclusively proved by the fact that the water of the springs and pumps in the city, upon which many of the people have depended for their supply, when subjected to a few days of summer temperature, exhale the same fœtid gases which arise from the docks. The chemical analyses of Professors Remsen, Tonry, and others also proves that the water in many of these drinking-wells is so charged with deleterious elements that the use of water from them, as well as from the springs in the city, for drinking purposes has been forbidden by the health department. But these waters are far from being indicators of the composition of the fluids pervading and constantly flowing from the substratum of the city into the harbor. They have their pure sources in the elevated regions at a distance; they follow fissures in the rocks, and strata more or less isolated from the general formation under the city, and enter it with a pure volume, and subsequently commingle with the polluting product of the city in the wells. They are, therefore, although contaminated, pure compared to that which flows from the privy-wells into the subjacent soil, and finally into the harbor.

If a total suppression of the privy-well system should be determined upon in favor of a general system of sewerage, which the city so much needs, a question would arise as to the most efficacious and economical method of carrying out this measure. If the sewers are constructed with a view not only of performing a sanitary office but at the

same time to receive and conduct the volumes of water which fall upon the surface during storms, it will necessitate adequate dimensions, and which are vastly in excess of what the first duty would require. These excessive dimensions would be imposed upon tubes which must be maintained in accurate form and position, of smooth and regular interior, water-tight throughout, and secure from all liability to fracture, obstruction, and escapement, increasing to a corresponding extent the cost of securing these features. They must also be provided with special cleaning, trapping, and ventilating arrangements on the same scale—features, in part, unnecessary for the second duty alone.

The *débris* with which the public streets are always strewn—sticks, stones, bricks, and every variety of trash—will be constantly swept into these sewers by a sudden torrent of rain, causing obstructions troublesome to remove and frequently choking them to the extent of forcing their promiscuous contents into the streets and cellars. They arrest within their numerous traps deposits of the foulest nature, requiring the most awkward and offensive operations for their removal. The traps for intercepting gases are more apparent than real. The small body of water interposed absorbs the gases on one side and exhales them on the other, a process which increases with the pressure within the sewers; while most frequently the obstruction interposed by the trap only determines the escape of the gases into sleeping apartments instead of the open air of the streets.

A sufficient and uniform supply of water is absolutely essential to the proper operation of a sanitary sewerage; but the sewers, which are designed to be assisted in their action by the surface drainage of the streets, find such assistance to fail them totally at the very period when it is most needed, that of heat and drought, or else they are disrupted or choked, and their contents diverted by a deluge of rain succeeding the drought. Most frequently the assistance of the rain is either absent, unnecessary, or in injurious excess.

To provide for the passage of storm-water requires not only the extra expense of the large scale upon which such nice and particular work as required for sanitary sewerage must be executed, but it requires conditions, due to the size of the vent, least favorable to the flow of the limited and uniform volume which alone can be relied upon. Instead of having a channel with the least surface in contact with the fluid, which is the measure of the resistance to the flow, this becomes the flat arc of a large circle, presenting a much greater surface of contact to the same volume. Where the inclination of these sewers is slight, a greater depth of water is acquired by accumulation, with consequent stagnation and putrefaction; where the inclination is rapid, floating solids become stranded along the sides and bottom with still worse effect.

A consideration which has influenced the adoption of the combination system is the advantage of having the beds of the streets to coincide with each other where they intersect, and thus avoid the interruption caused by the gutters of one street extending across the middle of the other, which occasions either an annoying check in the speed, a disagreeable jolt, or a complete stalling. This is obviated when the streets are provided with sewers. The gutters then terminate at an inlet instead of crossing the other street, which enables the middle of both to coincide in a common plane.

This system requires such an extent of sewers for surface drainage that it is combined with the other as a measure of economy and justification. The evil effect of it is illustrated in the sewerage of several American cities, notably the city of Washington, whose streets have been graded and paved with special reference to the driving of elegant equipages and vehicles of pleasure. Here every inlet informs the passer-by of the existence of a stagnant cess-pool beneath the street, or of the incomplete transportation of matters assigned to an insufficient volume.

In the city of Baltimore this gutter interruption is, in many places, remedied by bridging them over with plates of cast-iron, corrugated upon the upper surface, which yields a most disagreeable noise to every passing wheel. At every heavy rain they become choked with the trash and garbage washed down from streets and alleys, creating an overflow above them and leaving a deposit of putrescible matters beneath them.

In many of those streets coinciding with the natural depressions on the surface of the ground the water accumulates during heavy rains to such an extent as to become a formidable obstruction to pedestrains, and frequently invades the sidewalks and cellars. During severe freezing weather, with the ordinary drainage, large accumulations of ice occur, which have to be removed from time to time to enable vehicles to pass. At some of these places stepping-stones have been provided, at others a complete remedy has been effected by sewers below the surface to carry off the storm-water. In these instances a sewer for the surface drainage, leading to the nearest available outlet, no city should forego; but much the largest proportion of the streets have only to drain the territory in their immediate vicinity, and but for the constant small stream of impure water discharged from the houses would need no gutters, for there could be no objection to the storm-water flowing in a uniform sheet over the entire breadth of the street over the curb-stones of the sidewalk, as its duration would be

short, and concur with the absence of pedestrains from the streets. If the streets were so graded as to form a regular plane, instead of a convex surface, and thus constitute one broad gutter with a flat bottom, and bounded with the curb of the sidewalk on either side, there would be no interruption at their crossings, and the surface drainage would be perfect.

So long as it is permitted to discharge impure waters upon the streets, it will be a necessity to concentrate them into gutters; but if the law compelled all such fluids to flow into sewers, with which every house necessarily formed a junction, and allowed only the pure water of the private hose, the street-sprinkler, and the storm and showers to flow upon the streets, the gutters over the largest area might be dispensed with and one crying nuisance abolished.

In every well-governed city the dirt which must necessarily accumulate in the streets is regularly swept up and carried off; and where the streets are properly graded and paved this operation is an inexpensive one and can be rapidly and economically performed by machines. In some cities the value of the product is more than the expense of removing it. In Baltimore, where the streets are in the most primitive condition, this process is an expensive and tedious one, and consequently is resorted to at long intervals, during which the dirt becomes the sport of the winds, and, in the summer time particularly, is distributed through the dwellings. But whether this sweeping is sufficient or not, there can be no very great evil in allowing the washings of the streets during falls of rain to flow directly into the harbor. Its character and quantity is such that it does not readily undergo offensive decomposition, and its removal thus is always accompanied with that great preventive, a copious supply of fresh water; but this cannot be said of those innumerable and perpetual streams of composite fluid which now flow in all the gutters, either lawfully or they are too widely distributed and too difficult to trace to be prevented by the police. That which finally reaches the harbor must contribute its full share to its pollution, unless it has exhausted its effect upon the atmosphere of the city during its slow journey. The greater part is absorbed by the sandy soil upon which the gutters and pavements are laid, passing through the spaces between the bowlders and spreading through the heated soil near the surface. The proper disposition of all such fluids is unquestionably the sewer of sanitation.

If the well-system is abolished—which a proper regard for the future health of the community demands—and the surface drainage continued, with sewers only in the principal depressions, and they restricted only to storm-water, then a system of special sewerage, devoted exclusively to sanitation, must be adopted. In this we have to deal with a subject whose conditions are constant and uniform, and within the range of easy calculation. This highly important operation will admit of the application of the most scientific and skillful devices in the smallest proportions necessary for one office, and enable the sanitary engineer to accomplish his object with certainty and economy. And if any apparatus or process should hereafter be invented by which the barren and impoverished soils which cover so large a territory in the neighborhood of the city may be profitably restored to a healthful and attractive fertility as the result of such operations, the special system of sewerage will be the best calculated for their application. The sewer for receiving the storm-water, though important, should be postponed to that which is a necessity. It has become imperative to lessen the nuisance occasioned by the present system of privy-vaults, as well as that occasioned by the drainage from kitchens and sculleries and overflowing slop-tubs and garbage-receptacles, and that resulting from the pursuit of many industries, all of which now join in the general chorus of the gutter rill. The following from the Baltimore Sun of August 5, 1880, is pertinent to the subject:

"SEWERS, SEWAGE, AND SEWAGE FARMS.—Before long the city council of Baltimore may be called upon to consider the question of sewerage. Dr. Billings, an excellent authority, has expressed his opinion that a system of sewers is essential to the health of the city. So also declare the State board of health and our local board of health commissioners. What is meant by 'a system of sewers' we have yet to learn. An intercepting sewer, constructed on the plan of the Hambleton survey, to catch and carry off the drainage that now finds its way to the inner harbor, only to be dredged out again at a large annual expense, is undoubtedly desirable, provided sufficient fall can be given to it to take the sewage far enough down the river, either to be utilized on what are called 'sewage farms,' or, if discharged into the river itself, to prevent its return by the inflowing tide. The plan of sewerage recently adopted in Memphis and other cities may possibly be found suitable to Baltimore. It consists in the use of pipes to carry off the house sewage only, leaving storm-water to be carried away by surface drainage. Such a plan, with the surface drainage and also the smaller net-work of sewers discharging into the main intercepting sewers, might be carried out at a not unreasonable cost, considering the sanitary benefit to be derived from it, and the trouble and expense and continual harassment to which the city is subjected in finding unobjectionable dumping grounds. Philadelphia is at this time experiencing a similar trouble, not only from the poisoning of the soil by the liquids from privy-wells, of which it is

estimated that nearly 500,000 persons make use, but also from the fact that 'the sewage of 290,000 persons daily reaches the rivers, which, after a long drought, are likely to be polluted.' But underlying these facts is the important question as to what shall be done with all this sewage. Experience thus far favors its use by distributing it among sewage farms. In Massachusetts this distribution of the sewage on a small scale has been attended with marked success. There the experiment has been tried at the Danvers and Worcester Asylums. At the latter the sewage farm is distant half a mile from the building, and the sewage is carried to it through simple trenches and distributed at the rate of 3,000 gallons per acre. At the Danvers Asylum the sewage is carried about the land near to the house by means of simple wooden troughs, and it is said that 'with a little intelligent care all offensive odors are avoided.' In both instances much larger crops are raised than ever before. At Lenox the subirrigation plan of the famous English agriculturist, Mr. Mechi, has been adopted, the sewage being distributed through a series of ordinary tile drains about a foot below the surface of the ground. In England this mode of distributing sewage has been extensively used, and the plan has been fostered by the annual prizes which the Royal Agricultural Society offers for the best sewage farms, including similar farms in Ireland and Scotland. There are about one hundred of these sewage farms in operation in Great Britain. According to the report recently published, and as might have been expected, it has been found that the great market gardens within easy distance of large cities return the most profit from the use of sewage. One other important conclusion is reached by the committee. It is in respect to the sanitary effects of sewage on the hands employed on sewage farms. It was found that 'among the persons either living or working on the farms the average rate of mortality did not exceed three per thousand per annum,' which is 'not more,' it is said, 'than an equal number of selected lives taken from an agricultural district.' What the effect of sewage on the health of field hands would be in our hotter climate is yet to be determined."

The sanitary condition of Baltimore is a subject worthy the consideration of both the municipal, State, and national health authorities. That the existing evils are dangerous *per se* there is no evidence to affirm; but how far they may be capable of developing any of the diseases which need some germ or some special chemical or physical cause for their initiation is a subject upon which science throws a feeble but sinister light. The combined labors of those who pursue chemistry, biology, medicine, and physics are required to guide the sanitary engineer in any measures except those which are dictated by the instinct of man and even animals, to seek pure air and water, to hide, avoid, and banish every element rejected in the organic process of life, or capable of contaminating the atmosphere.

The ever-growing necessities of an increasing population should be met by a corresponding activity of the mind and will. But a large portion of the inhabitants of our large cities find themselves powerless to obey those instincts which nature seems to have provided to indicate the true sources of health. They find themselves imprisoned in close quarters with thousands of their fellows, in an atmosphere saturated with foul vapors, without the means of securing sufficient or appropriate food or even pure water, and without protection from the extremes of heat, cold, and dampness. It is for the more fortunate, intelligent, and thoughtful members of the community, who witness these arsenals of disease gathering the elements of avenging epidemics, to aid with their influence in inaugurating a thorough and systematic plan of sanitation, and to take the first steps in a series which shall finally complete it.

Epidemics need only those unknown but sufficient causes to kindle a flame which may include in its devastations the most salubrious as well as the most filthy district; and the sordid man who locks up his pocket and votes against a tax to prevent or correct such evils cannot guard his own spacious and luxurious abode against the malady his own avarice has helped to originate. "*Pallida mors æquo pulsat pede pauperum tabernas regumque turres.*

Respectfully submitted,

C. W. CHANCELLOR, *M. D.*

APPENDIX O.

REPORT OF COMMITTEE ON THE NOMENCLATURE OF DISEASES AND ON VITAL STATISTICS.

WASHINGTON, D. C., *October* 20, 1880.

SIR: The committee upon the nomenclature of disease, &c., appointed at the conference called by the National Board of Health, in Washington, May 6, 1880, respectfully submit the following report and recommendations:

As regards the nomenclature, we have, in accordance with our instructions, carefully considered the matter, and have communicated the results of our deliberations to the committee of the Royal College of Physicians, which is now engaged in the revision of this nomenclature.

We append herewith (marked A) a copy of the communication which we have addressed to this committee, and the matter will probably be presented in more detail by a member of our committee, Dr. Folsom, who will visit England within a short time.

As several States and a number of cities in this country are just beginning to publish reports of their mortality statistics, we deem it expedient to present at once a preliminary report as to the best methods of tabulating such statistics, and upon this we would remark as follows:

I. The question as to the best forms of tables for the *publication* of such statistics is quite different from the question as to the best forms to use in their *compilation*. Very much compilation work must often be done to obtain results which can be published more briefly and economically in a very different form, or which may not seem worth publication at all after they have been obtained.

II. The three great objects to be obtained by the publication of mortality statistics are, 1, as a warning of the existence of an excessive amount of disease, especially of the preventable forms, with reference to immediate action; 2, to educate the people as to the importance and interest of such matters, by getting them to compare their own situation as to healthfulness with that of other communities, and to see themselves as they are; 3, as material for the studies of the scientific statistician and the seeker into the causes of diseases.

The first object can be best attained by weekly reports for towns and cities, which reports should be brief summaries of the data of the previous week. A postal-card form for such a weekly statement is appended, which is essentially the same as that used by the National Board of Health. (Appendix B.) It is advised, to secure uniformity in time, that the week be held to end on Saturday at noon, and to include all deaths reported up to that time, without reference to the date of death.

This postal report should be sent to the National Board of Health for publication, and the information contained in it should also be given to the local press, with such additions and comments as the health officer can conveniently furnish. Under some circumstances, as during the prevalence of an epidemic, such reports would be required daily.

The second object above referred to is to be promoted by the publication, side by side, of many such weekly reports as have just been mentioned, and by similar comparisons in annual reports. It is unnecessary to refer to the forms needed for this purpose, as they will be discussed under the next head.

The third object is the one that presents the real difficulties. We will first take the case of a city, or single registration district, where the mortality tables are to be compiled directly from the original records.

III. The data to be compiled are (or ought to be) date of death, age, sex, color, birth-place of parents, nativity, occupation, social relation, locality of death (street, ward, &c.), and cause of death.

The items "color" and "birth-place of parents" are relied on to show the race [illegible] nationality of the decedent. The item "nativity" refers to the birth-place of [illegible] decedent, and is useful rather for genealogical and judicial purposes than for v[illegible] statistics. (With regard to the item "race," it is not to be taken [illegible] equivalent [illegible] "birth-place" or "nativity." The birth-place of the parents, whic[illegible] be show[illegible] on the certificate, will be usually taken to give the "race.") The [illegible] the com[illegible]

pilation of these data are to be compared to the living population, the birth-rate, the occupied area, the meteorological and other special conditions of the environment, and with the results obtained in the same locality in previous years.

For statistical purposes, the month should be made the unit of time, although the tabulations we are now discussing will be published but once a year. For educational purposes, and as a matter of local interest, it will be well to publish monthly summaries, which, however, would differ little in form from the weekly reports already referred to.

IV. The first table which a city should give in its annual mortality report, and which should be compiled in the same form, should be one showing the number of deaths from each cause by age or sex.

In all cities where the number of persons of different races or nationalties is large enough to make it worth while this table should show also for each sex and age the races, as American whites, American blacks, English and Scotch, French, German, &c. We think this should be done for any race or nationality which forms 5 per cent. or more of the total population.

A form for such table is appended, marked Table I. So long as each cause of death appears separately the precise nosological arrangement or order of sequence is a matter of minor importance, but we advise following the order of the nomenclature of the Royal College of Physicians that the order may be the same in all the tables. The information contained in this table is essential to the vital statistician. It cannot be abbreviated without losing much of its value; it will not do to give deaths by ages separate from those by sex. The division of ages, indicated in this table, is the least which will permit of making comparison with the statistical reports of other countries. It is desirable, however, that the deaths under one year be still further subdivided, and that special studies be made of the deaths by days in the first month and by months in the first year. The importance of distinguishing the race or nationality is very great in the United States at the present time. No other country presents such an opportunity for the study of the effects of race or nationality in disease and mortality; nor will it be possible in this country to study it many years, and hence the great importance of making use of the fleeting opportunity.

In those places where the birth-place of parents is not reported the only means of deciding the race or nationality, besides the color distinction, is the item of nativity, which should in such case be used, although it is of little value as regards young children.

If a city publishes this table or set of tables and nothing else, it will be of the greatest value for statistical and sanitary purposes.

V. The second table to be *compiled* should show the number of deaths from each cause, and the number of deaths at certain ages, by months, with distinction of sex. In most cases, however, it will not be worth while to publish this compilation in full, since in regard to many causes of death season has little influence, and the probabilities of any useful increase to knowledge from comparison of mortality statistics with monthly means of temperature, humidity, barometric pressure, and other meteorological data, is, as regards most diseases, very slight.

A form for a table of this kind, such as we would recommend for publication, is appended, marked Table II.

The compilation form for table No. I may be combined with the form for table No. II in one large compilation-sheet by placing the list of causes of disease in a column between columns for months and those for age.

VI. The third table which we advise should show the relations of causes of death to social relations, *i. e.*, to marriage and to occupations. A form for this purpose is appended, marked Table III.

With this we close our recommendations of forms for municipal mortality statistics. The forms recommended are not intended to exclude other methods of tabulation. They give the minimum amount of mortality statistics which a city should publish. If it gives these together with its population, the health of its people can be compared with that of other localities, which is the great object of the statistician and the reason why uniformity in the forms of tabulation is so very desirable. To enable the statistician to compare the health of the same city at different periods it will often be necessary to continue compilations according to forms already in use, but this should not prevent the use of the forms which are here recommended and which are intended to secure the means of comparison with other places. We have said nothing about tabulation by wards or districts, as we shall have to consider tabulation by localities when speaking of forms for States, &c., and we have not alluded to or provided for the presentation of the results in terms involving ratios, either to living population, to birth-rate, or to total death-rate, because we are stating the essential and minimum amount of work to be done by the local statistician, but we think it highly desirable that such computations of percentages and ratios should be made and published in the local reports as a means of educating not only the people, but the compiler.

The forms of tables for compiling and publishing the mortality statistics for States

are governed by the same principles as those for cities, but another factor enters into them to a much greater extent, viz, locality. The unit of area for this purpose in a State should be at least the county or its equivalent (as the parish in Louisiana), and in many cases smaller subdivisions into towns, townships, &c., will be desirable. Whatever unit may be taken the first thing to be done is to obtain for each of them those compilation tables specified as a minimum for the cities; that is, tables 1, 2, &c. Having done this, the next step is to calculate for each locality or unity of area the ratio of the deaths to the estimated living population, and the total number of deaths for the following classes, viz, for deaths under one year of age, deaths under five years of age, and deaths from about twenty of the principal causes or groups of causes.

A comparison of these results will indicate the localities in which further study and special compilation will be desirable. The tabulation of the mortality statistics for the whole State should be, first, the same table as No. 1 for a city; second, the same as No. 2 for a city; third, the same as No. 3 for a city; fourth, a table showing comparison of number of births and deaths.

With regard to classification by localities in a State, there should be a table giving the total number of deaths for each locality by age, sex, and month, and a table giving the number of deaths from each of the twenty principal causes or groups of causes of deaths for each locality. It will be understood that what we are here advising for a State is the minimum amount of statistical information which it should furnish with regard to its mortality, and the same remarks apply to this as to reports for a city above referred to.

The "report on a uniform plan for registration reports of births, marriages, and deaths," presented to the American Medical Association, in 1859, by a committee of which Dr. Sutton of Kentucky was chairman, should also be consulted by registrars of vital statistics. The forms of tables for reporting deaths, given in that report, are mainly taken from the Massachusetts reports of 1854, and do not seem as desirable as those recommended in this report.

We advise all those engaged in tabulating mortality reports for a city to study the forms of tables used in the city of Providence and in the District of Columbia. And in like manner those upon whom rest the responsibility for tabulating the mortality statistics of a State should especially study the forms of tables used in the last registration report of Massachusetts, the last registration report of Michigan, and the last annual report of the registrar-general of England, in which will be found additional forms and many suggestions of value.

As a matter of convenience, we have had prepared and append herewith outlines of the principal forms contained in these reports.

All of which is respectfully submitted.

JOHN S. BILLINGS, M. D.,
Surgeon, U. S. Army.
THOMAS J. TURNER, M. D.,
Medical Director, U. S. Navy.
P. H. BAILHACHE, M. D.,
Surgeon, U. S. Marine Hospital Service.
CHARLES F. FOLSOM, M. D.,
Secretary State Board of Health of Massachusetts.
EDWIN M. SNOW, M. D.,
Superintendent of Health and City Registrar, Providence, R. I.

Dr. JAMES L. CABELL,
President National Board of Health.

APPENDIX A.

NATIONAL BOARD OF HEALTH,
Washington, D. C., October 18, 1880.

SIR: I have the honor to transmit herewith a communication from the committee on nomenclature, appointed by the National Board of Health, United States, submitting suggestions with regard to the revision of the nomenclature of the college, and respectfully request that it may laid before the committee of the college charged with revision.

Dr. Charles F. Folsom, a member of this committee, will probably be in London in November next, and it is hoped that he will have an opportunity of meeting the committee of the college and of making further explanation.

Very respectfully, your obedient servant,

J. S. BILLINGS,
Surgeon U. S. Army, Chairman.

HENRY A. PITMAN,
Registrar of the Royal College of Physicians, London, England.

WASHINGTON, D. C., *October* 20, 1880.

The committee appointed at the conference of registrars of vital statistics, called by the National Board of Health in Washington May 6, 1880, to suggest the principal additions to and changes in the nomenclature of the Royal College of Physicians of London which seem most desirable at the present time, and to confer with the committee of the college in charge of revision of said nomenclature with reference to the obtaining of a uniform system for Great Britain and this country, respectfully submit the following suggestions:

I. The synonyms of the new nomenclature should be made as complete as possible, so that any name of a disease which might be used by a physician educated anywhere in Europe may be found in the index. This is especially desirable in this country, where we have physicians from all parts of Europe. The appended list of names of diseases, which are not found in the index to the nomenclature of the college, is submitted in this connection.

II. Malaria, as producing intermittent and remittent fevers and other similar affections, is an important subject of nomenclature and nosological classification in a large part of this country, and it is desirable that this group should be brought together and made distinct.

III. It is advised that the committee consider in the new nomenclature whether a step might not be taken towards establishing a distinction between what may be termed clinical and pathologico-anatomical nomenclature, the first being names of symptoms or groups of symptoms, the second of results of disease. Such a step might be the direction that certain terms, such as posterior spinal sclerosis, cancer of the pancreas, &c., shall be used only to express the result of a post-mortem examination; while certain other terms are to be used only in the absence of such an examination, as is directed in the present nomenclature of the college with regard to encephalitis.

IV. It is considered that the groups of "General Diseases A" and "General Diseases B" are too large for any practical purpose. One of the chief uses of a classification of diseases in such a nomenclature is to enable registrars of vital statistics to summarize certain facts with regard to causes of death. But the classification which is of value to the student of sanitary science is that which is, as far as possible, based on etiology.

From the point of view of the sanitarian, to group small-pox, remittent fever, and typhoid fever together, simply renders valueless the statistics; and the same may be said of the placing together rheumatism, syphilis, cancer, and phthisis.

It is believed that both Group A and Group B can be so subdivided as to be much more convenient for registration and summarizing than they now are, and for this purpose the following scheme is submitted (A):

The only points in which this scheme varies essentially from the plan of the present nomenclature is in the introduction of the group of "diarrhœal diseases," and in the placing with syphilis the other venereal diseases. We do not attempt to go into details with regard to the rearrangement of the local diseases, which will require in many places additions and transpositions to make them correspond to the present state of medical science and to the nomenclature in use by specialists.

We append, however, as a suggestion, and as a part of this report, papers which have been prepared at the request of the committee by specialists, as follows, viz:

1st. Nomenclature of diseases of the eye and ear, by Dr. Swan M. Burnett, Washington, D. C.

2d. Nomenclature of diseases of the nervous system, by Prof. H. C. Wood, of Philadelphia, Pa.

3d. Nomenclature of diseases of the female urinary and generative organs, by Dr. James R. Chadwick, Boston, Mass.

All of which is respectfully submitted.

JOHN S. BILLINGS,
Surgeon, U. S. Army.
THOMAS J. TURNER,
Medical Director, U. S. Navy.
P. H. BAILHACHE,
Surgeon, U. S. Marine Hospital Service.
CHARLES F. FOLSOM, M. D.,
Secretary State Board of Health of Massachusetts.
EDWIN M. SNOW, M. D.,
Superintendent of Health and City Registrar, Providence, R. I.

Proposed subclassification or grouping of "General Diseases A" and "General Diseases B."

GENERAL DISEASES A.

GROUP 1.—Cholera.
Yellow fever.
Plague.
} Deaths from each of these diseases will be reported separately.

GROUP 2.—Small-pox.
Scarlet fever.
Measles.
Rötheln.
Mumps.
Whooping-cough.
GROUP 3.—Diphtheria.
GROUP 4.—Typhus fever.
Typhoid fever.
Cerebro-spinal fever.
Relapsing fever.
GROUP 5.—Malarial fevers.
Malarial cachexia.
Dengue.

GROUP 6.—Diarrhœa, acute.
Diarrhœa, chronic.
Cholera morbus.
Cholera infantum.
GROUP 7.—Erysipelas.
Pyæmia or septicæmia.
Puerperal fever.
Hospital gangrene.
GROUP 8.—Glanders, or farcy.
Charbon, or malignant pustule.
Contagious aphthæ.
Milk sickness.
GROUP 9.—Influenza.

GENERAL DISEASES B.

GROUP 1.—Rheumatism—Gout.
GROUP 2.—Venereal diseases—Syphilis.
Chancroid.
Gonorrhœa.
GROUP 3.—Cancer and tumors.
GROUP 4.—Tubercular diseases.

GROUP 5.—Rickets, cretinism, scurvy, purpura, hœmophilia, anæmia, chlorosis.
GROUP 6.—Diabetes.
GROUP 7.—Leprosy.
GROUP 8.—Beri-Beri.

LIST OF NAMES OF DISEASES NOT GIVEN IN THE INDEX OF THE NOMENCLATURE OF THE ROYAL COLLEGE OF PHYSICIANS.

Abscess perinephritic.
Abscess peri-prostatic.
Adenoma.
Aphasia.
Athetosis.
Anosmia.
Blepharoptosis.
Blepharospasmus.
Compression of brain.
Congestion of brain.
Compression of cord.
Congestion of kidney.
Chloasma.
Chorion, cystic disease of.
Cellulitis.
Coccoygodynia.
Cylindroma.
Diabetes insipidus—polyuria, polydipsia.
Dura mater, ossification of.
Dipsomania.
Dyspareunia.
Dysidrosis.
Diplacusis.
Empyema.
Entero-colitis.
Epulis.
Ecchymosis.
Eclampsia infantum.
Ebriositas.
Fibroma.
Fever typho-malarial.
Fragilitas ossium.
Giant-celled sarcoma.
Glioma.
Glosso-labial paralysis—bulbar paralysis
Hæmoglobinuria.
Hæmophila—hæmorrhagic diathesis.
Hæmorrhagic remittent fever.
Headache—cephalalgia.
Hydatids, uterine.
Hemicohrea.
Hysterotomy.
Heat stroke—thermic fever, insolatio, ictus solis.
Inflammation of kidney—nephritis.
Keloid.
Lung, acute congestion of.
Laceration of cervix uteri (parturition).
Lymphoma.
Meningeal apoplexy.
Milk sickness.
Myxoadenoma.
Myoma.
Noma.
Nostalgia.
Nausea marina—sea-sickness.
Oöphorectomy.
Othæmatoma.
Oxaluria.
Pachymeningitis.
Peri-hepatitis.
Peri-nephritis.
Peri-prostitis.
Proctitis.
Peri-typhilitis.
Physometra.
Pleurodynia.
Pharyngitis, acute.
chronic.
Psammoma.

WELL-WATERS—Continued.

Number of analysis.	Sample.	Total solids.	Loss on ignition.	Free ammonia.	Organic ammonia.	Oxygen required for organic matter.	Nitrous acid.	Nitric acid.	Chlorine.	Microscopic appearances.
170	Campbell, Grenada, Miss.: 30 feet deep, with 3 feet of water; privy 50 yards distant; clear and colorless.	12.0	1.5	.000	.002	.0244	...do....	..do...	5.6	Mineral matter, filamentous algæ, infusoria.
171	Dancy, Holly Springs, Miss.: 18 feet deep, with 3 feet of water; 80 feet from privy; clear and colorless.	20.0	3.0	.000	.003	.0732	...do....	..do...	.8	Cotton, wood, and a few infusoria.
172	Female College, Holly Springs, Miss.: 32 feet deep, with 3 feet water; no stables; clear and colorless.	7.0	1.0	.001	.004	.1172	...do....	..do...	1.2	Sand.
173	Calhoun, Holly Springs, Miss.: 30 feet deep, with 6 feet water; 30 feet from livery stable; clear and colorless.	41.0	7.5	.000	.004	.0586	...do....	..do...	5.6	Sand, cotton, and woody fragments.
174	Manning, Holly Springs, Miss.: 26 feet deep, with 5 feet of water; stables and privy 100 feet distant; clear and colorless.	13.0	2.5	.000	.005	.1807	...do....	..do...	1.0	
175	Craig, Holly Springs, Miss.: 20 feet deep, with 3½ feet of water; clear and colorless.	11.0	4.5	.001	.005	.0488	...do....	..do...	.6	Mineral particles, wood, and a few infusoria.
176	West, Holly Springs, Miss.: 15 feet deep, with 3 feet of water; 40 feet from surface privy; clear and colorless.	5.5	3.0	.0012	.007	.0684	...do....	..do...	.6	
177	Buchanan, Holly Springs, Miss.: 24 feet deep, with 5 feet of water; no stables, &c.; clear and colorless.	1.5	0.5	.000	.001	.0097	...do....	..do...	.4	Sandy particles.
178	Sevier, Brownsville, Tenn.: 15 feet deep, with 4 feet of water; 50 yards from surface privy; clear and colorless.	37.5	2.0	.001	.006	.0434	...do....	..do...	12.0	Sand, wood, and a few infusoria.
179	Hernando and Clay streets, Memphis: 90 feet from vaults; well deep and bricked; water slightly clouded.	44.0	14.0	.002	.003	.0340	...do....	.022	2.0	Sand, clay, and a few infusoria.
180	Barnes, Waldron avenue, Memphis: 42 feet deep with 10 feet of water; 100 feet from shallow vault; situated outside limits of city; clear and colorless.	32.0	13.0	.0006	.008	.0048	...do....	.022	1.8	Mineral grains and diatoms.
181	D. Bond, Brownsville, Tenn.: 75 yards from surface privy and stables; clouded.	12.0	2.0	.002	.004	.1215	...do....	None.	2.2	Cotton, clay, some decaying vegetation, and infusoria.
182	344 Madison street, Memphis: 30 feet deep, with 25 feet of water; vault 21 feet distant, 15 feet deep.	40.0	10.0	.0004	.003	.0796	...do....	...do...	2.2	Sand and a few infusoria.
183	Wilson, Brandon, Miss.: 30 feet deep, with 4 feet of water; stables 50 feet distant; faintly clouded.	14.0	2.5	.001	.013	.0635	None.	None.	3.4	Mineral particles, decaying wood, and filamentous algæ.
184	Clinton, Brownsville, Tenn.: 32 feet deep, with 3 feet of water; 90 feet from stable; clear and colorless.	26.0	2.5	.0012	.011	.4062	...do....	..do...	6.6	Many infusoria and but little decaying matter.
185	42 Winchester street, Memphis: Nearest vaults 37 feet distant; clear and colorless.	225.0	112.5	.001	.005	.0678	...do....	18.338	36.0	Sand and a few fragments of wood.
186	39 Main street, Memphis: Well very deep, 50 feet from vaults; clear and colorless.	82.0	28.0	.0016	.005	.0729	...do....	.022	5.2	Chiefly mineral grains.

[illegible] Brandon, Minn.; 18 feet deep; 5 feet of [illegible]

[illegible]	66.0	45.5	[illegible]

[illegible] face water
[illegible] ate the spring;

WELL-WATERS—Continued.

Number of analysis.	Sample.	Total solids.	Loss on ignition.	Free ammonia.	Organic ammonia.	Oxygen required for organic matter.	Nitrous acid.	Nitric acid.	Chlorine.	Microscopic appearances.
209	Wolf, Grenada, Miss.: 13½ feet deep, 20 inches of water; clear and colorless.	16.0	3.5	.012	.018	.2345	.0210	....	6.0	A mass of organic matter and organisms, paramecia, anguillula, rotifera, filamentous growths, human hair, and epethelium.
210	24 Front street, Memphis: Well very deep; 14½ feet from vault on east; 21 feet from vault on west; clear and colorless.	91.0	33.0	.007	.005	.0486	None.	.095	14.0	A few mineral grains.
211	Jackson, Miss.: 31 feet deep; stable 6 feet distant; clear and colorless.	90.0	10.0	.003	.032	.2051	Trace.	....	7.8	Many cotton fibers, entangling diatoms, kerona, and paramecia.
212	Exchange Hotel, Brownsville, Tenn.: 32 feet deep, with 3 feet water; 90 feet from vault and 150 from stable; clear and colorless.	53.5	16.0	.004	.014	.0224	.0115	4.130	12.2	Much decayed wood and other vegetable matters, with paramecia in large numbers.
213	Galt House, Brownsville, Tenn.: 26 feet deep, with 3½ feet water; 30 feet from vault; clear and colorless.	45.0	22.0	.001	.004	.0147	.0463	9.453	14.0	Mineral grains, cotton fibers, anguillula and paramecia.
214	86 Madison street, Memphis: 38½ feet deep; vault 83 feet distant; 60 feet deep; clear and colorless.	162.0	67.0	.0024	.003	.0368	Trace.	13.338	27.0	A few mineral particles.
215	Rather, Holly Springs, Miss.: 24 feet deep and 3 feet water; stable 15 feet distant; clear and colorless.	32.0	10.5	.002	.009	.2735	None.	.398	4.4	Much organic *débris*, bacteria, filamentous growths, anguillula.
216	Levy, Holly Springs, Miss.: 20 feet deep, with 3 feet water; 40 feet from vault, and 30 from stables; clear and colorless.	64.0	27.0	.001	.013	.0928	...do....	1.689	9.2	Organic decay, paramecia, anguillula, and vorticela.
217	Meyers, Holly Springs, Miss.: 20 feet deep, 3 feet water; 200 yards from cemetery; clouded.	24.0	7.0	.002	.019	.1465	...do....	.523	5.8	Vegetable and mineral matter, rotifera, anguillula, and paramecia.
218	Moore, Brownsville, Tenn.: 25 feet deep, with 4 feet water; 150 feet from stables and vaults; clear and colorless.	93.0	33.0	.002	.014	.0439	...do....	7.146	21.4	Decayed vegetation, and vast numbers of infusoria and confervoid filaments.
219	Cedar Well, Brownsville, Tenn.: 35 feet deep, 4 feet water; 30 yards from vault, 75 from stables; slightly clouded.	33.0	13.0	.001	.016	.0147	...do....	3.100	4.6	Amphileptus and anguillula, and much vegetable decay.
220	Klyce, Brownsville, Tenn.: 22 feet deep, 4½ feet water; 100 yards from stables and privy; slightly clouded.	15.5	7.0	.002	.034	.0344	...do....	2.034	2.2	Decaying vegetation; no infusoria; anguillula in large numbers.
221	Bond, Brownsville, Tenn.: 32 feet deep, with 3 feet water; 50 yards from privy and stables; clear and colorless.	38.0	8.0	.020	.007	.0440	...do....	1.505	5.8	Much vegetable matter, infusoria, bacilli, anguillula.
222	27 Main street, Memphis: Well very deep; 37 feet from deep vault; clear and colorless.	217.0	78.0	.005	.056	.1020	...do....	30.481	30.4	Very little decaying matter, but vast numbers of infusoria, vorticella and cercomonas.

223	50½ Front street, Memphis: Well very deep; 10 feet from vault; clear and colorless.	146.0	70.0	.005	.010	.0680	...do....	3.342	24.0	As last, but without the vorticels.
224	Third and Mill streets, Memphis: Well deep; 35 feet from full vault; clear and colorless.	115.0	45.5	.011	.018	.3797	...do....	3.294	13.0	Kerona and paramecia; little vegetable decay.
225	371 Vance street, Memphis: No particulars; clear and colorless.	103.0	47.0	.0008	.018	.0980	...do....	3.993	10.0	Sand, cotton, vegetable *débris* and bacteria.
226	38 Drew street, Memphis: 26 feet deep, with 14 feet water; 15 feet from nearest vault, 30 feet deep and full; vault on higher level; faintly clouded.	110.0	53.0	.023	.033	.5944	...do...	7.711	14.4	
227	20 Jackson, street, Memphis: 64 feet deep, with 30 feet of water; nearest vault 41 feet distant, 40 feet deep, and full; vault on higher level; clear and colorless.	151.0	68.0	.003	.038	.3736	...do....	6.437	28.0	Mineral particles entangled in cotton with various organic matters, rotifers, vorticels, and anguillula.
228	116 Front street, Memphis: 60 feet deep, with 12 feet water; 6 feet distant from vault; clear and colorless.	166.0	73.5	.0006	.030	.2450	...do....	17.154	25.8	
229	178 Poplar street, Memphis: 40 feet deep; nearest privy 53 feet distant, 25 feet deep, and filled to 3 feet from surface; faintly clouded.	58.0	24.0	.009	.048	.7105	. do....	3.185	9.6	Much clay in sediment, amphileptus, and anguillula.
230	Opposite 162 Saint Martin street, Memphis: 20 feet deep, with 4 feet water; vault 30 feet distant, 7 feet deep, with 5 feet of contents; vault on higher level; slightly clouded.	112.0	33.0	.003	.009	.2878	...do....	10.883	11.0	Clay, vegetable decay, anguillula.
231	Valance and Tchoupitoulas streets, New Orleans: Depth 18 feet; used when cistern water-supply runs short; 40 feet from privy; dark in color and clouded.	66.5	9.0	.143	.062	1.2099	...do....	.096	7.7	Sand, much decaying vegetation, zoospores, oscillatorians, paramecia.
232	158 Chestnut street, New Orleans: 10 feet deep, with 7 feet of water; dark and clouded.	110.0	12.0	.020	.030	.3940	...do....	.726	30.6	Sand, woody tissue, kerona, rotifera, and arachnidians.
233	Hampson street, New Orleans: 18 feet deep; 20 feet from stable, 30 from privy; dark and clouded.	60.0	16.0	.026	.041	.4717	...do....	.096	16.0	Swarming with paramecia; vegetable *débris*.
234	Burdette street, New Orleans: 18 feet deep; 20 feet from vault and stables; dark and clouded.	126.0	40.0	.292	.044	.7881	...do....	.096	22.4	Large amœboid masses; lacrymaria and cercomonas, much organic decay.
235	Lawrence and Bloodgood streets, Mobile, Ala.: 20 feet deep; 30 feet from vault; clouded.	97.0	44.0	.004	.012	.1054	...do...	23.333	14.6	Vegetable matter; naguillula; no infusoria.
236	Lawrence and Ealava street, Mobile, Ala.: 18 feet deep; 35 feet from vault; clear and colorless.	60.0	10.0	.002	.010	.0943	None.	4.402	13.0	Sediment small; anguillula.
237	Conception street, Mobile, Ala.: 25 feet deep; 50 feet from vault; clear and colorless.	6.0	3.5	.011	.003	.0167	... do....	.370	1.2	Clay simply.
238	Conception street (bored well), Mobile, Ala.: 30 feet from vault; clear and colorless.	21.0	6.0	.044	.009	.0277	... do....	2.935	3.0	Mineral matter; no active life.
239	Broad street, Mobile, Ala.: 20 feet deep; 20 feet from stables; 30 from vault; clear and colorless.	118.0	19.0	.0006	.017	.0943	... do....	9.180	39.0	Mineral particles, confervoid filaments, zoospores, and recent woody tissue.

SPRING-WATER.

240	Parnell's Spring, Brandon, Miss.: Well protected; no sinks or stable near; clear and colorless.	10.0	2.0	.001	.004	.0195	... do....	None.	1.15	Sand.
241	Youst's Spring, Brandon, Miss.: No privies or stable near; but several stagnant pools of surface water which in wet weather might contaminate the spring; clear and colorless.	17.0	3.0	.001	.010	.0077	... do....	.. do...	.8	

SPRING-WATER—Continued.

Number of analysis.	Sample.	Total solids.	Loss on ignition.	Free ammonia.	Organic ammonia.	Oxygen required for organic matter.	Nitrous acid.	Nitric acid.	Chlorine.	Microscopic appearances.
242	Public spring, Holly Springs, Miss.: Clear and colorless.	31.0	4.0	.002	.007	.0835	... do....	.. do...	3.8	Sand, decaying vegetation, and infusoria.
243	Laundry Spring, Ward 1, Holly Springs, Miss.: Clear and colorless.	7.0	5.0	.064	.009	.0684	... do....	.. do...	.6	Sand, decaying vegetation, and many infusoria.
244	Memphis Spring, sent to New Orleans by Dr. F. W. Reilly for examination: Clear and colorless.	80.0	15.0	.005	.005	.1332	.7243	.. do...	24.8	Sand, decaying vegetation, and many infusoria.
245	Hydrant water, Health Office, Mobile, Ala.: Clear; faint straw-color.	6.0	3.5	.004	.010	.3552	None.	.110	.275	Sand, confervdoi filaments, and zoospores.
246	Hydrant water, Market Exchange, Mobile, Ala.: Clear; faint straw-color.	6.0	3.5	.004	.010	.3829	... do....	.110	.275	Sand, confervdoi filaments, and zoospores.

RIVER-WATER.

Number of analysis.	Sample.	Total solids.	Loss on ignition.	Free ammonia.	Organic ammonia.	Oxygen required for organic matter.	Nitrous acid.	Nitric acid.	Chlorine.	Microscopic appearances.
247	Wolf River water obtained at mouth of river from surface after heavy rains November 18, 1879: Water opaque from fine particles of reddish clay.	44.0	6.5	.022	.071	.5783	... do....	None.	.45	Clay, sand, infusoria, and vorticela.
248	Mississippi River, New Orleans, March 10, 1880, high water: Opaque from clay and sand.	29.0	8.0	.016	.050	.4566	... do....	.. do...	.30	Clay, sand, infusoria, and vorticela.
249	Wolf River water as supplied to Memphis November 12, 1879: Opaque from clay.	49.7	6.5	.001	.037	.3010	... do....	.. do...	.20	Clay, sand, infusoria, and vorticela.
250	Wolf River water, Memphis supply, December 15, 1879, when Mississippi River was over 10 feet above low water, causing stagnation in the mouth of Wolf River: Opaque from clay; sedimented for two days before examination.	30.0	5.0	.001	.085	.5685	... do....	.. do...	.20	Sand, clay, and an occasional animalcule.
251	Mississippi River water, trapped December 15, 1879, above the mouth of Wolf River, and 25 feet below the surface: Opaque from clay and sand; sedimented for two days before examination.	20.0	6.0	.002	.086	.4655	... do....	.. do...	.35	Sand, clay, and an occasional animalcule.
252	Mississippi water, Memphis, November 18, 1879, above mouth of Wolf Liver, midstream, and at a depth of 30 feet from surface; depth of river 60 feet; stage of water 1 foot 7 inches, and rising 4 inches in twenty-four hours: Water heavily clouded.	28.0	7.0	.003	.017	.3207	... do....	.. do...	1.00	Sand, clay, and an occasional animalcule.

253	Mississippi water, above Memphis, in center of channel and 30 feet below the surface; stage of water 7.5 feet and rising 3 inches in twenty-four hours, December 2, 1879: Very turbid; sedimented for three days before examination.	20.0	4.5	.001	.013	.3736	... do....	.. do...	.50	
254	Wolf River water, midstream at Raleigh December 2, 1879; river at medium stage; last rain on 28th November, 1879: Very turbid; sedimented for three days before examination.	32.5	6.5	.003	.020	.4471	... do....	.. do...	.15	
255	Wolf River water from in front of influx pipe of Memphis water works, from surface, medium current and stage of water: Very turbid; sedimented for three days before examination.	36.5	6.5	.001	.028	.4593	... do....	.. do...	.15	
256	Elmwo d Creek, Memphis: Turbid from clay particles.	23.0	3.5	.001	.033	.5297	... do....	.. do ..	.15	Clay and vorticella.
257	Wolf River water; Peabody Hotel cisterns; water stored in August, when river was low and almost free from turbidity; drawn and examined November, 1879: clear and colorless	28.5	4.5	.001	.004	.0437	... do....	.. do...	.45	Clay only.
258	Wolf River water; Gastin's Hotel cisterns; examined November, 1879: Clear and colorless.	12.5	2.5	.0004	.003	.1069	... do....	.. do...	.20	Sand, clay, and zoospores.
259	Wolf River water; cistern 177 Union street, stored October; drawn and examined six weeks thereafter: Clear and colorless.	12.5	3.0	.0006	.008	.1701	... do....	.. do...	.80	
260	Wolf River water, filtered through animal charcoal, November, 1879: Clear and colorless.	26.0	7.0	.0004	.0015	.0195	... do....	.. do...	.20	Some fine particles of clay.
261	Mississippi River, filtered March, 1880; wood charcoal: Clear and colorless.	27.5	3.0	.078	.004	.0000	... do....	.. do...	.625	Nil.
262	Mississippi water, filtered through English sandstone, at Jesuits' college, New Orleans: Clear and colorless.	21.0	3.0	.005	.027	.1776	... do....	.145	.50	Protococcus, zoospores, vorticella, and mineral grains.
263	Mississippi water, filtered through sandstone, New Orleans, March, 1880.	21.0	7.0	.000	.005	.1387	... do....	None.	.30	Nil.
264	Louisiana ice: Clear and colorless.	2.0	1.0	.033	.011	.0444	... do....	.. do...		Woody tissue from saw dust.
265	Boston ice: Clear and colorless	.75	.25	.010	.012	.0388	... do....	.. do...		
266	Swamp-water, New Orleans: Clear and colorless.	121.0	28.0	.048	.090	1.3450	Trace.	.. do...	4.5	Protococcus cells, bacteria, amœba, cercomonas, many active and energetic vorticella.
267	Sewage, New Orleans.	82.5	31.5	.240	.120	1.1544	... do....	.. do...	25.0	Clay, bacteria, rotifers, and some large annelids.
268	Potomac water, Washington supply, May 30, 1880: Clear and colorless.	13.0	1.0	.000	.012	.1843	None.	.. do...	.20	Clay and decaying vegetation; entomostraca, rotifers and anguillula.
269	Water from well at Ship Island, near Quarantine Station; six weeks in bottles before analysis: Clear and colorless.	14.0	7.0	.0003	.011	.3783	...do	.. do...	1.55	Sand, clay, much woody tissue, and a few specimens of euglena.

NOTES TO PRECEDING TABLE.

Nos 1 and 3 show the high ammonia and albuminoid figures obtained at the commencement of a rainfall. Nos. 2 and 4 manifest the purer character of the water towards the end of the fall, although the free ammonia in No. 4 is much increased on account of electric conditions. The microscope gives the general constitution of the atmospheric impurities brought down by the rainfall. Since No. 1 is the average water of four hours of rainfall, and No. 3 that of three hours of fall, it is plain that to exclude impure water from a cistern, the use of the cut-off must be continued long after the grosser impurities from the atmosphere and roof have been washed away. In No. 5 the ammonia is high, probably from products of combustion deposited on the roof. These analyses were made to show the character of the water which was entering the cisterns for storage.

Nos. 6 to 16 are samples of the purest waters found in tanks. The large ammonia figures in No. 6, 7, 9, and 11 are from recent rainfall. The permanganate result is higher in No. 6, the sample being from a shingle roof, than in the others, which are from slate roofs. The nitric acid in No. 6 is identical with that in No. 5, the estimation in both cases having been made to ascertain the normal figure. The chlorine of No. 7 is higher than usually occurs with good water. The microscopic characters are satisfactory in all, the zoospores which appear in Nos. 12 to 16 having, so far as ascertained, no sinister meaning. They are present in the rainfall No. 1.

After the distillation of the albuminoid ammonia from No. 16, the contents of the retort were permitted to stand for twenty-four hours, when a further distillate was obtained which contained no ammonia. (See also No, 244.) No. 16 was brought in by the sanitary inspector, as a sample of the good cistern water in his district. Compare its results with No. 44. In No. 17, the rotifers are noticeable. They seldom occur in water which gives such good results by the chemical processes. There are probably foul accumulations at the bottom of the cistern, which, under the influence of increased temperature, will give a less satisfactory drinking water. Nos. 18 and 19 are good waters, obtained by trapping the sedimentary matters in an iron tank and permitting the cisterns to fill by overflow from it. The sandstone filter in No. 19 exercises little or no influence on the purification of the water. It was found to be a simple diaphragm through which the water passed with the mechanical separation of suspended particles, but with no exposure to oxidizing influences. Compare Analyses 262 and 263.

Nos. 20 to 33 must be considered fair specimens of cistern water. They will probably become tainted during the summer season. Nos. 20 and 23 bumped viciously during the albuminoid distillation.

The large oxygen figures corresponding with the shingle roof are seen in Nos. 27 and 29, where the free ammonia also is high. The origin of the ammonia in No. 25 is unknown. The cyclops, hydrachna, and ciliated infusoria in Nos. 20 to 27 are so often met with in waters which universal experience shows to be wholesome, that their presence indicates only a larger amount of organic matter in the waters than in those which precede them on the list. The albuminoid figure in No. 27 is high on account of the presence of these ciliated animalcules. The sediment was stirred from the bottom of the cistern before collecting the water, under the mistaken idea that the analyst required a goodly proportion of it in the sample bottle. The rotifers in Nos. 28, 29, and 32 are a higher phase of animal development, and lead the way to the more impure waters which follow.

Nos. 29, 30, and 31 were furnished by a gentleman much interested in the methods for insuring purity in cistern waters, and were intended to illustrate the efficiency of such methods; No. 29 to show the character of the water from a shingle roof, collected as is customary with no effort to exclude roof-washing, and stored in a cistern which had not been cleaned in four years; Nos. 30 and 31 to show the same rainfall as shed from a slate roof with a cut-off guarding the entrance to the cisterns. Unfortunately, the latter samples were contaminated by rotten and alcoholic corks in the containing vessels, which gave rise to the anomalous microscopic appearances, and deprived the experiments of comparative value.

The ammoniacal contamination in Nos. 34 and 35 is sufficiently explained by their proximity to the "works." The albuminoid ammonia in the latter was not determined.

Nos. 36 to 40 are not such waters as should be contained in the cisterns of public institutions.

Nos. 40 to 46 are undoubtedly bad waters, the rotifers, vorticella, amœboids, &c., showing the rankness of the impurity, and rendering chemical investigation unnecessary. No. 44 was brought by the sanitary inspector as an illustration of the bad cistern water in his district. No. 45 was sent as a sample of suspicious water in connection with malarial remittents occurring among the persons making use of it. No. 46 is from a well-paved and non-malarious part of the city of New Orleans. It was furnished by Dr. C. B. White, medical director of the Citizens' Auxiliary Sanitary Associ-

ation, in order that lead, if present, might be detected, as the persons using the water had been affected with many anomalous symptoms. No lead was found, but the impurity of the sample was such that the analyst believed himself dealing with swamp water furnished for the purpose of testing his results. During the progress of the analysis a severe case of remittent fever developed in the house supplied with the water. Suspicion was aroused in the minds of the people, and the cistern was disused. When the analyst reported the water as the essence of malarial remittent, the occurrence of this fever in the house was made known to him. The albuminoid ammonia in Nos. 42, 45, and 46 distilled in quantities which diminished 50 per cent. in successive measures of 50 c. c. In the others the evolution was more rapid.

The principal points which have to be considered in connection with the rain-water supplies furnished by raised cypress-wood tanks are:

1st. The impurity of the rain-water at the commencement of the fall, as shown by analyses Nos. 1 and 2, and even after the fall has continued for some time, as in the sample No. 3.

2d. The additional impurities which are washed from the roof, especially by the first portions of a rain-shower. This is illustrated by the character of the dust which settles from the dry atmosphere of a city. A specimen of this dust was obtained from some open upper rooms of a public building in New Orleans. It gave 17.2 per cent. of moisture, 34 of matter destroyed by heat, and 48.8 of mineral residue. Of the dry dust 11 per cent. was dissolved by maceration in water for twenty-four hours. Six of these 11 parts were inorganic salts, and 5 were organic matter, which manifested its quality by requiring per 100 parts 668 parts of oxygen for its destruction, and yielding per 100 parts 6 parts of albuminoid ammonia. The residue, insoluble in water, contained nitrogen enough to furnish .5 per cent. of organic ammonia, indicating the presence in it of organic matters which prolonged maceration and fermentative changes might reduce to a soluble condition.

3d. The accumulation of this roof-washed matter in the bottom of the cistern and the putrefaction or fermentation which is liable to be set up in it during warm weather. The rate of accumulation was determined from observations in fifteen cisterns to be about one inch per year. The sediment when dried consisted of 73.4 per cent. of mineral matter and 26.6 per cent. of matter destroyed by heat. One hundred parts yielded .54 part of organic ammonia.

4th. The diffusion in the stored waters of the mobile upper layers of the accumulated sediment caused by the intrusion of fresh rainfalls. The suspended matters in a cistern water thus disturbed are chiefly organic, the weightier minerals refusing to rise. Hence the water is rendered impure for several days after each fall by matters which ought not to have been admitted into the cistern, or which ought not to have been disturbed after their admission and original subsidence.

5th. The insufficiency of the purification effected in the cleanest and best of these tanks, as compared with that which is accomplished in underground brick cisterns. The exclusion of light and the lowered temperature in the latter have more to do with the purification than the material of the cistern. Water drawn from brick cisterns which were not sunk was found at Fort Preble, Me., during the summer season to have the same characters as that from the cypress-wood tanks of New Orleans. Extreme cases are of course excluded where rotting wood contaminates the water.

To obtain as pure a water as can be furnished by this method of rain-storage, the first of all rainfalls should be rejected by means of a cut-off until not only the roof but the atmosphere is thoroughly washed; the fresh inflow should be conducted into the cistern in such a manner as to prevent disturbance of the contained water; and the cistern should be clean, covered, shaded, and well ventilated. The cut-off with ordinary care and attention will prevent accumulation of sediment from the roof, but it is doubtful if even the most careful persons will continue its use long enough to insure a pure water from the atmosphere. The rain-supply is so uncertain that when it falls, too much of it must not be cast aside, lest the cistern remain unfilled. People with two reservoirs can run the waste water into one for domestic uses and collect a pure rain-water for drinking supplies in the other; but the double cistern is not common. To store the rainfall in a single cistern and at the same time obtain a water for drinking which shall be above suspicion is impracticable. The cut-off may and should be used to wash the roof and preserve the cistern from excess of sediment, but its use so restricted will not furnish a reliable water. The raised tanks protect New Orleans from the ravages of typhoid fever, but the specific poison of malarial fever may be present in the atmospheric sewage which is carried into them. If this possibility cannot be prevented by the continued use of the cut-off, there is no resource but filtration. Purification in the household of the small store of water required as a drinking supply may be readily and cheaply effected. The household filter can be made by any tinsmith. It consists of a modified funnel, the body of which rests on a tin bucket or receiver, while the tube projects downward to the bottom of the said bucket. The lower end of the tube is tied over with some filtering cloth. Three-fourths of its length is filled with granulated animal charcoal and the upper fourth

with sand. The upper end of the tube projects about half an inch into the body of the funnel to permit of tying a filtering cloth over the top of the sand. The angle between this projection and the sloping sides of the funnel serves to trap solid matters. To clean this filter the filtering cloth guarding the top of the tube has to be removed, washed, and replaced. At longer intervals, when the filter shows signs of clogging, half an inch of the upper layer of sand may be removed and replaced by fresh material. At yet longer periods the whole of the contents of the tube may be dumped out and renewed. Earthenware is more durable than tin, and would preserve the water cooler during the warm months. A sample of cistern water containing .016 part of organic ammonia, when purified by passing through wood charcoal in a filter as above described, gave .007 part. But animal charcoal should be used, in which case such a water as that of this cistern would be reduced almost to organic purity.

The albuminoid ammonia process affords the best insight into the character of rain-water in raised tanks, the results being uniformly in accordance with the microscopic evidence. When the albuminoid amounts are deprived of their fractional value by erasing the decimal points and the ciphers which follow them, the figures which are obtained constitute a useful scale of relative impurity. By means of them an appreciation of the character of different waters can be conveyed to those who, while interested in the waters in question, are ignorant of the methods of analysis and of the value to be attached to the determination of the organic ammonia. When it is known that 0 expresses an organically pure water or one containing .000 part, 3 or 4 (.003 or .004 part) a pure spring water, 10 (.010 part) a good rain water, 20 (.020 part) a dangerous water, and 90 (.090 part) water from the swamps, the sanitary position of a cistern water, with an impurity figure of 12, 22, or 39, &c., can be communicated with precision.

Nos. 47 to 75 are samples of good water from sound cisterns. Calcic carbonate was found in the residue of many, as in Nos. 52, 54, 62, 63, and others, and was believed to indicate leakage from the soil, but when found in Nos. 64, 65, and 66, in comparatively large quantity without a corresponding increase in the chlorine, the lime was referred to its proper source—the lining of the cistern. Excess of total solids was dependent on the lime carbonate except in Nos. 59, 62, 68, 73, and 74, where clay particles were the cause. The chlorine is large in No. 73 and would indicate leakage but that the microscope shows Wolf River clay to be present, and suggests that the chlorine may remain from river water recently stored in the cistern. The albuminoid figures are under .010 in all these cases. The ammonia is variable, and from the permanganate results nothing could be predicated of these waters as a class. Witness, for instance, the large figures in Nos. 62, 66, and 70. The microscopic characters comprise soot and mineral matters with more or less of decayed vegetation, zoospores, euglena peranema, acomia, and enchelys, with occasionally the cyclops. The chlorine figures show the soundness of the cisterns and the impossibility of sewage contamination in any of the waters. Sometimes, as in Nos. 58 and 59, where the waters were uninviting in appearance from soot or clay discoloration, and the cistern in the latter case at least in such dangerous proximity to vaults, the question of wholesomeness depended entirely on the amount of chlorine found. The free and albuminoid ammonias and the permanganate results might have been obtained from a water contaminated by sewage, but in that event the chlorine would have been higher than .05 and .15 parts. The traces of nitric and nitrous acids with the free ammonia and the proximity of the cistern to the privy vault suggest sewage in the case of No. 75. With any increase in the chlorine this water would have to be considered dangerous. The albuminoids of the water have undergone oxidation while stored.

Nos. 76 to 85 are from sound cisterns, as evidenced by the quantity of chlorine; but although the albuminoids are under .010, the amount of vegetable decay and profusion of microscopic life in the sediment, as in Nos. 77 and 78, with the rotifers of Nos. 76, 79, 80, 81, and 83, the vorticels of No. 82, and the anguillula of No. 84 indicate the waters as less desirable than those which precede them. No. 84 is chemically an excellent water, but as anguillula is usually an inhabitant of foul cisterns, its presence in connection with the small increase in nitrates was made the basis of a suspicion against the water. This cistern furnished the supply of one of the public schools, and as such supplies should be above suspicion, an adverse report was rendered, which resulted in orders for the purification and disuse of the neighboring vaults and the cleaning and relining of the cistern. In No. 85, the cistern water of another of the public schools, the comparatively large loss on ignition called for a determination of the nitrates. Although the chemical results do not throw doubt on the water, the lively microscopic field in connection with a small portion of decaying solids and the nitric acid increase, suggested the cleaning out of the cistern as a means of precaution.

In No. 86 an examination of the chemical results would indicate sewage pollution as probable. The small oxygen and albuminoid figures with the relatively large amount of free ammonia might result from ureal decomposition, especially when accompanied by the chlorine, which is present in this case. Nitrates were determined in this water on account of its suspicious character. An adverse report would have

been rendered, but the excess of chlorine was satisfactorily accounted for. A few months before, at the beginning of the year 1879, the yellow-fever season, some one connected with the institution (Christian Brothers' School) threw common salt into the cistern as an antiseptic or preservative. A consideration of the quantity said to have been introduced, in connection with the subsequent rainfall, the capacity of the cistern, and the chlorine found, corroborated this statement as to the origin of the suspected sewage salt, and sustained the microscopic appearances which until then had stood alone in their favorable testimony.

Nos. 87 to 101 are shown by the chlorine to be samples from sound cisterns, although calcic carbonate was present in them all. No. 91 has a slight excess of chlorine, but the clay particles which accompany it indicate the possibility of Wolf River water having been at one time contained in the cistern.

Nos. 87 to 91 are usable waters, judging from their general appearance and repute and the microscopic characters of their sedimentary matters, although in No. 90 the albuminoid figure is high, probably from a disturbance of the sediment in the cistern as in the case of the raised tank No. 27.

Nos. 92 to 100 are undoubtedly bad waters, basing the opinion on the microscopic appearances and the albuminoid and oxygen figures which testify to a large organic contamination of the same nature (except in No. 100) as that which is present in impure, freshly-fallen rain. Even No. 94, with its large amount of carbonaceous matter, as shown by the permanganate, yields its albuminoid ammonia in the same manner as the rainfall. The successive distillates of No. 100 gave .06, .03, .01 of organic ammonia.

Nos. 95 and 96 have the albuminoids small compared with the others, but in other respects they are similar. But for such cases and those which, like No. 90, have the albuminoids higher in an apparently purer water, the amount of organic ammonia would be the index of the character of rain-water stored in sound cisterns.

Nos. 93 and 94 are from cisterns which were used by a settlement of 100 people, 25 of whom were seized by yellow fever during the epidemic of 1878; mortality, 13.

The owner of the cistern from which No. 97 was obtained was suffering from an attack of malarial hæmaturia, simulating yellow fever, at the time of the examination. The analyst is indebted for the sample and for the privilege of investigating the febrile case to the kindness of Dr. Wirt Johnson, secretary of the Mississippi State board.

The nitrites in Nos. 92, 96, and 100 must have been formed during the storage of the waters, as the cisterns are manifestly impermeable.

Nos. 98 and 99 are condemned, irrespective of their proximity to vaults. They show that a cistern can be made practically impervious, for in them any leakage would be shown by an excess of chlorine.

Three hundred people use the water No. 100.

The large amount of free ammonia in No. 101 indicates sewage or a condition of cistern which interferes with the natural process of purification. The chlorine figure contra-indicates sewage pollution. The microscopic appearances in this water were deceptive. No vegetable decay was discovered. The study of this sediment and of others in connection with it showed that a water containing much organic matter in solution may give no indication of its character under the microscope if it is drawn without disturbing its perfect sedimentation. If, however, there is present in the sample bottle some small particles of decaying vegetation, much organic life will be found around them if the water is impure. (See analyses Nos. 126 and 127.)

In Nos. 102 to 115 the albuminoid figure is below .010. They are samples of good water drawn from leaky cisterns. They do not show the presence of sewage pollution, but they are liable to be contaminated at any moment. Relining would suffice to render them valuable reservoirs, provided there is no collection of filth in their neighborhood; but in No. 109, for instance, where the vault is represented as being only 5 feet distant, no measure less radical than the disuse of the cistern could be considered compatible with sanitary requirements. In this case, the small amount of free ammonia guarantees wholesomeness for the present. In other samples, as Nos. 107 and 114, the absence of free ammonia bespeaks present purity. In No. 111, where the ammonia might be considered suggestive of urea, the microscopic characters free the water from suspicion. In No. 112, also, the microscopic evidence is valuable The cistern from which No. 106 was obtained could hardly be called a rain-water reservoir. It was supplied originally by the rainfall from the roof of a hotel; but the building having been destroyed, the cistern was disused for several years until water was discovered in it by some colored squatters, who resumed its use. The water supply is derived from the soil, like that of a shallow well.

Nos. 108 and 115 have the chlorine quantity no larger than that of some raised tanks, but cistern waters which obtain such chlorine figures from roof washings are usually highly charged with organic impurities. The purity of these specimens appears to indicate that the small increase in the chlorine comes from the soil by leakage. No. 112 was at one time stored with Wolf River water, and preserved the clay in the sediment as a record of the storage. The large loss on ignition in 114 appears to have been moisture chiefly.

Nos. 116 to 119 leak, No. 117 to a small extent, so that it is only by comparing the general character of the water with the chlorine figure, as in Nos. 108 and 115, that the leakage can be established. In a sound cistern .3 part of chlorine would be accompanied by a greater amount of organic impurity than is present in this case. Chemically urea might be decomposing in these cisterns, but the microscopic characters contra-indicate the supposition. No. 116 with its .010 part of albuminoid ammonia is as good a water as many previously recorded which yields less, while Nos. 120 and 121, with .005 and .007, respectively, seem, from the microscopic appearances, to be less desirable waters than even No. 116. The permanganate results in Nos. 116, 120, 122, which are from slate roofs, differ very noticeably from the others in this list which are shed from shingles. The comparatively large amount of free ammonia in No. 122 with its proximity to the vault, renders communication between the reservoirs a probability; but the small quantity of nitrates, and especially of chlorine, show this to be slight, if any. In view, however, of the possibility of danger, this cistern should be condemned.

Nos. 123 to 125 are undoubtedly bad waters, although the absence of free ammonia and nitrates proves freedom from sewage. The cistern of No. 123 was examined after the analysis and found to be in want of repairs; its contents rose and fell with the ground water. No. 124 was furnished in connection with cases of malarial remittent fever, which prevailed in the house supplied by this water. Its albuminoid ammonia distilled thus: .07, .03, .015, .005 = .024 part. The absence of sinks and stables, and small amount of free ammonia, show that there can be no recent animal matter to account for the chlorides. No particulars were furnished concerning the cistern from which No. 125 was obtained, except the verbal remark, in response to the inquiry of the analyst as to whether he was dealing with a very foul well or cistern water, that the cistern was in want of repairs and was not used much.

Nos. 126 to 129 were condemned as contaminated with sewage, the opinion being based on the fact of leakage and the proximity of vaults; on the incomplete oxidation of organic matter which had taken place in No. 127, and on the nitrates and microscopic characters in No. 128. No. 126 illustrates the difficulty which is sometimes presented in determining the presence of sewage in a cistern water from the laboratory examination alone. Nos. 120 and 126 were sent for analysis without information concerning the surroundings of the cisterns, the samples being simply lettered for identification. Leakage from the soil was established in No. 120 by the chlorine being larger than was consistent with soundness, unless the water had been highly charged with impurity from roof-washings, which was manifestly not the case, while the absence of sewage was proved by the small amount of free ammonia. But notwithstanding the favorable results of the albuminoid and permanganate processes, the water, on account of its sediment, was not considered unexceptionable. In No. 126, however, although leakage was distinctly proven, neither the ammonias nor the oxygen could discountenance the idea of sewage, nor could they prove its presence, for many sound cisterns had yielded similar results. The microscope indicated the water as organically impure, without showing that the impurity was derived from animal waste. The leak, however, was small, yielding only a total of 8 parts. At least one-half of this total must have come from the roof, leaving only 4 parts or less as due to leakage. Nevertheless, this small proportion contained 1.3 parts of chlorine. The ground water of a pure soil would have contributed earthy salts to a considerable extent along with this quantity of chlorine. The probability, therefore, was that the chlorine came from sewage infiltration, and an opinion to that effect was rendered. The surroundings of the cistern when made known to the analyst appeared to sustain this view of the impurity of its contents.

In Nos. 130 to 136 the nitrates present show these waters to be tainted by that which has percolated through the soil and lost its organic nitrogen by oxidation. These water samples may or may not be unwholesome, but the cisterns from which they were drawn are situated where their leaky condition exposes them to a possible inflow of organic impurity. The likelihood of this can be best determined by an inspection of the sources of filth in their neighborhood. Many of the waters from sound cisterns give ammonia; albuminoid and oxygen figures similar to those in this list. No. 131, for instance, may be compared with No. 52, and Nos. 130 and 134 with Nos. 48 and 49, but the characters of the sediment are essentially different.

Calcic carbonate is recorded as present in all these waters, but in No. 135 it existed in minute quantity compared with the total. On this account, together with the amount of chlorine and nitrates, sewage infiltration oxidized in its passage was inferred as a contamination of the water. From the analysis, it was uncertain whether this water was drawn from a well or a leaky cistern, and as no information accompanied the bottle, other than that it came from 106 Union street, Memphis, and as no person appeared to make inquiries concerning the result of the examination, a sanitary inspector was dispatched to the premises with instructions to bring therefrom a sample of the water supply and to make note of its source. The specimen returned, which was reported as from a cistern, was examined as to its total solids and amount of

chlorine, and these agreeing with the results already obtained, the cistern was recorded as leaky and liable to intrusion of sewage. This case possesses some interest, as an attempt was made by means of it to throw doubt upon the accuracy of the writer's analytical work in Memphis. Interested motives apparently lay at the bottom of this effort, the financial interests of individuals as opposed to the sanitary interests of the community. Two weeks or more after the writer had left Memphis, a card appeared in one of the papers, wherein a Mr. Moore stated that he knew a gentleman in Union street who had presented to the analyst a gallon of pure rain-water, which had been condemned after examination as from a leaky cistern. It fortunately happened that the water from 106 Union was the only sample from that street which was upon the record. Pure rain-water, understanding by that phrase water collected from the clouds or perhaps from the roof in clean dishes, certainly does not contain 29 parts of total solids of which 13 are lost on ignition, 2.7 are chlorine, and .549 nitric acid, while its ammonia is greatly in excess of .002 and its albuminoids seldom as low as .010. That some mistake had been made by the gentleman who collected the sample was apparent; and as, on several occasions, the writer had found that an explanation of anomalous analytical results could be obtained when honestly sought for, as in the case of the common salt in No. 86, the Wolf River clay in No. 112, and the lager beer and alcoholic traces in waters which were not recorded after the impurity in the containing vessel was detected, he believed that in this case also the explanation might be discovered. On instituting inquiries at 106 Union street, it was ascertained that Mr. Moore himself lived there; and as the man who knew the gentleman who collected the pure rain-water seemed to be intimately associated with the gentleman himself, it was felt to be useless to attempt to obtain the particulars of the collection, as the motives which dictated the publication of the card, instead of a communication to the analyst in the first instance, would be equally effectual in suppressing any investigation into the origin of the chlorine in the so-called pure rain-water. No notice was taken of the card at the time, but more recently when the gallon of pure rain-water made its appearance in print a second time, a friend of the writer who was cognizant of the circumstances rose to explain. The analyst is indebted to Dr. F. W. Reilly for his defense. But the explanation which is required is not how chlorine, &c., came to be discovered in a pure rain-water, but how they came *to be* there. The gentleman whom Mr. Moore knows, knows more about this than anybody else; or if he does not, he ought to.

The samples Nos. 137 and 140 illustrate rank pollution by sewage, with ineffectual efforts at purification by natural filtration. Urea gives no result by the permanganate process, and if decomposition has taken place it gives none by the albuminoid process, but when it enters a cistern or well there usually comes with it or with its remains, sufficient organic impurity recognizable by these processes to condemn the water.

Nos. 138 to 140 were from three neighboring cisterns situated in an unsanitary locality, with the drainage of the neighborhood tending to the position of the last mentioned. The house supplied by No. 140 was notably unhealthy; two cases of malarial remittent, of severe type, were reported from it, and four of yellow fever, during the few months preceding the analysis. This water has higher albuminoids than that of the New Orleans drainage canals.

Nos. 141 to 149 were specially selected samples. The amount of chlorine present in an underground cistern water having been made the measure of its leakage when present in excess of the quantity usually found in raised tanks, a large number of the Memphis cisterns were examined by means of the simple chlorine estimation. From the number so examined these specimens were sent for, that their character might be thoroughly investigated to illustrate the quality of water with which a given quantity of chlorine might probably correspond. The albuminoids in the majority suffice to condemn irrespective of the nitrates and chlorine present.

Nos. 141, 143, 146, and 148 are less charged with organic impurity. The free ammonia is also noticeably less in these than in the others. The microscopic characters are satisfactory only in No. 141. Where the leakage is established, and there is doubt as to the unwholesomeness of the water, the proper action is manifestly to condemn the cistern to disuse or repairs, according to its vicinity to vaults, stables, and like sources of impurity, to the direction of the drainage, and to the level of the ground water in relation to the depth of the cistern. The total solids in No. 149 and probably in Nos. 144 and 148 contra-indicate the use of the water irrespective of organic impurity. The absence of living organisms in No. 149 is noteworthy.

Four hundred and forty-nine Memphis cisterns, excluding the 9 samples above recorded in full, were examined as to their chlorine amounts, with the following results:

No. of cisterns.	Chlorine.
127	under .075 part.
82	.075 to .15 part.
82	.15 to .30 part.
158	over .30 part.
449	

Those containing under .075 part were reported as from cisterns undoubtedly sound, and as being probably pure waters. Where the chlorine ran from .075 to .15 the cistern was reported as probably sound, the chlorine increase being referred to organic matter from the roof which would tend to throw doubt upon the wholesomeness of the water. With the chlorine ranging from .15 to .30, leakage to a small extent was indicated, or a most unwholesome condition of the water from accumulations of organic matter. These cases were recorded as probably leaky; while, where the chlorine was in excess of .3 part, the leakage was considered established.

Nos. 150 to 182 are samples of undoubtedly good well-waters. A few, as in No. 158, have the dissolved solids somewhat high, but experience has shown that no evil effects can be attributed to them. Their proportion of earthy salts is small. No. 182 was the only specimen which gave a marked cloudiness on boiling. On account of the large loss on ignition the nitrates in Nos. 179 and 180 were determined. In all the samples the free ammonia does not exceed .002, and the albuminoid ammonia is under .010 parts. The results of the permanganate deoxidations are strikingly different from those yielded by the stored rain-waters. Dr. Tidy, who relies mainly on the permanganate process, regards waters as of doubtful character which require more than .15 parts of oxygen. Few of those in this list exceed this amount. The chlorine varies much in quantity and gives little information of sanitary interest. It is sometimes stated that if the chlorine yielded by the well-waters of a given district is known, any increase in a particular water would give grounds for suspecting animal impurity. Theoretically, this appears to be sound reasoning, but practically there is not that uniformity in the chlorine figures of even a limited district which would enable one to form an opinion. Witness the varying quantities in the Grenada waters. The only value of the chlorine estimation is the testimony it bears to the nature of the inorganic matters which make up the sum of the total solids.

The microscopic characters are definite, the rotifers in Nos. 154 and 159 constituting the only exceptions. These animalcules are usually found in waters yielding larger albuminoid and oxygen figures. No. 177 is a sample of water as pure (using the word in both its chemical and sanitary sense) as can be found in nature. It is rain-water deprived of its atmospheric impurities by filtration through a bed of clean sand.

The surroundings of most of these wells are satisfactory. Elliott and Duckhill are settlements consisting of not more than a dozen scattered houses with the wells at a distance from sources of contamination, and, in the majority of instances, carefully protected. No. 165 is at a cross-roads, several hundred yards from the nearest house. Payne's place, No. 164, is a country house. The house in the village of Brandon, from which No. 150 was taken, is so separated from adjacent dwellings as to be virtually a country house; so, also, with some of the houses supplied by the Holly Spring waters. No. 180 is from beyond the city limits of Memphis. The Grenada wells, although situated in a comparatively settled locality, have no vaults in their neighborhood to permeate the soil and contaminate their waters. Surface receptacles and dry earth are in general use in Mississippi with the drainage away from the water source.

The list of well-waters which may be called of fair or usable quality is exceedingly small, containing only two samples, Nos. 183 and 184, out of eighty-nine examined. The former has the albuminoids rather high, but is otherwise satisfactory. The latter gives large permanganate results, which are believed to be from carbonaceous matter in the sample bottles.

Nos. 185 to 187 are the only waters which require to be condemned on account of their total solids, which consist largely of lime salts. Other specimens of well and cistern water have large mineral residues, but they are accompanied by organic traits which would condemn the water irrespective of the dissolved solids.

Nos. 188 to 194 are unwholesome waters from excess of organic impurity, but in none of them is there ground for supposing contamination from vaults. No. 188 is an extremely hard water; its excess of chlorine is apparently geologic. No. 189 does not represent a fair sample of the water furnished by the well. A new pump had been inserted on the day before the collection was made, and much organic matter which under ordinary circumstances would have lain quietly at the bottom was diffused through the water. The well from which No. 190 was drawn was in bad condition, its wood-work much decayed. No. 191 yielded a dark-colored hygroscopic and acrid matter in the residue. The loss on ignition was large from imperfect drying. This water was reputed excellent and wholesome. When the analytical results were made known, the impurity was referred by the owner of the well to certain foul, disused vaults in the neighborhood, but the distance of these vaults, the shallowness of the well, the direction of drainage, and particularly the absence of nitrates, seemed to contra-indicate this supposition. A close inspection by the writer excluded every possible source of impurity except that constituted by manure on the surface. The well was situated in a richly manured kitchen garden in which were many fruit-trees. The surface layer consisted of a dry, porous sand, but the tree-roots extended below this through the clay to the water-bearing stratum. The idea was therefore suggested that surface-water might be led into the well along the roots or through channels

formed by their decay. This theory of the contamination received support by a consideration of the surroundings of the well which yielded No. 192. Near by were no vaults or other sources of impurity, nothing but the manured soil and fruit-trees. Similar conditions were anticipated in No. 193, and when an inspection was made, the trunk of a large silver-leaf poplar was found to arise from the soil within 3 feet of the well, while the fence of the kitchen garden ran alongside. In the case of No. 194, the well was surrounded by large trees and an unused well half-filled with decayed leaves was situated within 20 feet of it. This sample differed from all the others in yielding its albuminoid ammonia in quantities which diminished 50 per cent. in successive distillates.

Nos. 195 to 202 are good waters notwithstanding the presence of the nitrates. But for the nitric acid no suspicion would attach to them. As it is, the surroundings of the wells appear to indicate that the nitrogen of the acid is well removed from its anterior state of organization. The three samples from Mobile are from a water-bearing stratum which is cut off from surface contamination by an impervious layer of clay. The nitrates are therefore the remains of organic matter which entered the stratum at its outcrop.

No. 203 has a higher albuminoid figure, but its small amount of dissolved solids and its microscopic characters place it among the usable waters.

Nos. 204 to 207 contain traces of nitrous acid, without any coexisting nitrates. No. 205 is apparently a good water; No. 206 is probably good. The well from which the latter was obtained had been cleaned out a few days before the sample was submitted and the water was not entirely free from the effects of the disturbance. No. 204 was also turbid from interference with its natural sedimentation. On account of the large loss by heat in No. 207 the nitric acid was determined, but with negative results. The microscopic characters of this water are decidedly inconsistent with purity, and in connection with the nitrites should cause it to be received doubtfully in spite of its freedom from albuminoids.

Nos. 208 and 210 are condemned on account of the free ammonia which they contain. In the latter the loss on ignition called for a determination of the nitrates. It is noticeable that in several instances of contaminated well and impure cistern water anguillula is present, unaccompanied by any other living forms, as in Nos. 42 and 43, already reported, and in Nos. 220, 230, 235, and 236.

In Nos. 209 and 211 the trace of nitrous acid is not associated with nitrates. They are both bad waters; in the latter the inorganic solids are sufficient to interdict its use. They consist mainly of lime salts.

Nos. 212 to 214 contain traces of nitrites along with nitrates. The last, however, is a good water in other respects except in containing an excess of dissolved solids. Organically it is pure, but the well which contains it is liable to invasion by unoxidized matters, and hence should be condemned. No. 207 gives similar albuminoid and permanganate results and contains also a trace of nitrites, but its freedom from dissolved solids and accumulations of oxidized nitrogen renders the well which furnishes it a less suspicious source than that which yielded No. 214. In No. 213 the nitrites, as in the two other cases, evidence the proximity of the organic store-house which furnished the nitrates, and the microscope testifies to impurity, although the free and albuminoid ammonia and the oxygen figures were low at the time of the examination, so low that the water would have been pronounced pure by any or all of the chemical methods which do not include a valuation of the nitrites and nitrates. The sample examined no doubt was pure, and a report to that effect would have been correct in so far, but the object of the sanitary officer in investigating a water comprehends more than an opinion on the half gallon submitted to him. The purity of this water depends upon circumstances which are liable to be changed by the first rain shower or other accident which will cause a more rapid inflow. The life in the sediment shows that there must have been more albuminoids in the water at a recent period, and the nitrites that the impurity may recur at any moment.

Nos. 215 to 239 are contaminated by sewage. In many the excess of inorganic solids depends entirely upon the presence of sewage salts, chlorides, alkaline carbonates, and nitrates. The free ammonia in some, as Nos. 231 to 234, is excessive; in others, as Nos. 225, 228, and 239, it has almost disappeared, but enough of the albuminoids persist to condemn the waters without reference to the existing nitrates. The presence of only a trace of nitric acid is noteworthy in the highly contaminated waters Nos. 231 to 234. This is owing to non-oxidation and not to destruction of pre-existing nitrates by sewage influx. No. 232, the least impure of these, shows the effort at purification by oxidation in the soil.

The permanganate results differ exceedingly in this list, from .0147 in No. 219 to 1.2099 in No. 231. The latter result was verified by repetition. Nos. 224 and 226 to 229 have the oxygen figure so large as to imply a vegetable origin to the organic matter. In these samples the albuminoid ammonia diminished by 50 per cent. in successive distillates. It might be assumed, however, that carbonaceous matters, when mixed with the animal albuminoids, retard the evolution of ammonia, but Nos. 231 to 234, which

have large oxygen figures, distilled their organic ammonia rapidly. In No. 215 the oxygen result first obtained and recorded was 1.1382, but this was so anomalous that a mistake was apprehended. The sample was contained in a drug-store alcohol bottle. A fresh supply collected in a clean bottle gave the tabulated result. The impurity in this water depended on the vicinity of a cow-stable and a broken curbing which admitted surface water in rainy weather. The well from which No. 216 was obtained was near the only deep privy vault which remained in Holly Springs. The impurity in No. 217 appeared owing to the presence of trees and a highly manured surface soil, as in several instances already recorded. The unwholesome quality of Nos. 218 to 221 in Brownsville is undoubtedly owing to the neighboring vaults, as in No. 216. Similar conditions aggravated by an increased density of population supply the Memphis wells, Nos. 222 to 230, with their large amount of sewage salts and organic impurity. Many of these, however, have a good deal of calcic carbonate and sulphate, and cloud densely on boiling. Three cases of typhoid fever were reported by Dr. W. W. Taylor, secretary of the local board, in the house supplied by the well from which No. 221 was drawn. No. 222 contains a large quantity of chlorides and nitrates, yet the microscopic field was full of life. This sediment may be compared with that of the sample, No. 149, which, with similar pollution but with increased solids, gave a perfectly dead field.

Nos. 231 to 234 are samples of the impure ground water of New Orleans. They are simply diluted sewage. (See analysis No. 267.) Alkaline carbonates are present in large quantity in these waters.

Nos. 235, 236, and 239 are shallow wells in Mobile, Ala. They obtain their impurity by inefficient filtration. Nos. 237 and 238 are deep wells in the same city, contaminated by leakage from the impure ground water. The former is but 25 feet deep, but its solids show its water supply to come from the stratum which is penetrated by the deeper wells, Nos. 200 to 202.

No. 240 is a pure spring water. No. 241 is a fair water, and would no doubt be improved in quality if some effort were made to protect the spring from accidental impurities. The filtration is imperfect in Nos. 242, 245, and 246. They are rain waters modified by their passage through sand. The ammonia in No. 243 is derived from the neighboring gas-works. No. 244 must be received as a dangerous water. The analyst knows nothing of its surroundings, but the large amounts of nitrous acid and chlorine show impurity to be in the vicinity. The ammonia, which in No. 143 is the innocuous remains of atmospheric precipitation, must in this case be looked upon with suspicion. A communication from Dr. F. W. Reilly, inspector National Board of Health, who sent the sample for examination, states that this water was much used by the people of Memphis in the early days of the city, and that it was a reputed cause of diarrhea. After the albuminoid ammonia was distilled from this sample, the alkaline liquid was permitted to remain in the retort for seventy-two hours, when a further distillation was made, but without the discovery of any more ammonia. Nos. 245 and 246 are from the same source—springs which constitute the hydrant supply of the city of Mobile.

River waters are so variable in quality from temporary disturbing causes that little can be predicated of their character from a single examination. As in dealing with questions of climate, the maximum, minimum, and mean annual temperatures must be known to insure an appreciation of the subject, so with regard to running waters their maximum, minimum, and mean yearly impurity must be ascertained with sufficient accuracy before an opinion can be warranted as to their wholesomeness. When a river is low there is usually a tendency to the deposition of suspended matters. Low water, therefore, corresponds with the period of minimum organic impurity. Heavy rains and snow-meltings contaminate the stream by bringing into it the sewage of the atmosphere—the various organic substances which have been seen to yield so much albuminoid ammonia. The increased flow prevents the deposition and consequent purification which ordinarily take place. Surface erosion, in addition, loads the water with turbidity, and organic matters from the soil are diffused through it under circumstances favorable to their solution. High water, therefore, corresponds to the period of maximum impurity. If the character of the water is known at these two stages, the variations in quality which occur during the year can be ascertained. They will be proportioned to the variations in the volume of the running water.

No. 247 shows the maximum impurity of Wolf River; No. 248, the maximum of the Mississippi taken at New Orleans when the river was above the danger line. Samples illustrative of the minimum of these streams were not obtained. No. 249 shows the condition of Wolf River water when the stream, as reported by Major Benyaurd, United States Engineer Corps, was at medium current and stage. No. 250 is from Wolf River at a time when the flood in the Mississippi caused a stagnation in the current which extended as high as the Memphis water-works. Its impurity is similar to that found in Mississippi water No. 251 collected on the same day, the river being then fully 10 feet over low-water mark. No. 252 gives the character of the Mississippi water when the stream was lower—1 foot 7 inches above low water.

None of these waters are sufficiently pure for use as a drinking supply. The albuminoids are excessive.

Nos. 253 to 255 illustrate the process of purification by settling as it takes place in Mississippi water, in Wolf River water from Memphis and in Wolf River water from Raleigh, 9 miles above the city of Memphis. The Wolf at this time was at medium stage and the Mississippi 7¼ feet above low water. The waters were permitted to stand for three days before analysis. The results speak markedly in favor of Mississippi water, and the cause is obvious. The sediment consisted chiefly of sand, which settled in the time allowed, while the clay particles continued to cloud the Wolf River samples. This subject has been already referred to in discussing the characters of mineral sediment.

Nos. 257 to 259 have no bearing on the quality of Wolf River, although they were sent to the analyst as illustrative of the character of that water at its purest. These are manifestly not running, but stored waters, subject to all the purifying influences which have been seen to change impure rain into pure cistern water. There is more than a verbal distinction here. The water was indeed river water when introduced into the cisterns. It was rain or spring water before it became river water, but we speak of a water not as it has been but as it is. So, in No. 260, which is Wolf River water filtered through animal charcoal, the analysis testifies to the efficiency of the filtration and not to the purity of the river water. This specimen in its natural condition yielded .037 part of albuminoid ammonia. No. 261 is Mississippi water filtered through wood charcoal. The unfiltered water gave 0.36 of organic ammonia. The large amount of free ammonia in this instance is believed to have been derived from the charcoal. Its action on the permanganate was similar to that of the pure water used as a standard.

The results were so unsatisfactory in No. 262, which was represented as Mississippi water filtered through sandstone, that an inspection of the arrangements was made. The filters consisted of sandstone basins, set in a frame-work like a washstand, with vessels placed underneath to collect the filtered water. The sandstone was choked and foul, and colonized the filtrate from its under surface. The passage was so tedious that more water was used from the basins than from the receivers. No. 263 is Mississippi water, with an albuminoid figure of .035, as filtered into the interior of a sandstone keg. The hollow "filtering stone" lay in the bottom of a tank, and was filled through its pores by the pressure of the superincumbent water. A ventilating pipe extended from the interior of the keg to above the high-water mark of the containing tank.

During the writer's stay in Memphis many of the citizens were interested in the quality of the hydrant or Wolf River water, some condemning it in unmeasured terms and others lauding it as one of the best and purest of natural waters. Appearances were certainly against it. Even when reported by the engineer officers as at medium stage and current, the water of this stream was loaded with reddish clay and with suspended and dissolved organic matters. The arguments of its advocates comprised the results of certain analyses, which were made some years ago, and the organic purity of the water, as shown by the present analyst, in certain sedimented and filtered samples. The purity established by the old analyses was a chemical purity. The water did not contain so much inorganic solids, so much calcic and magnesic carbonates and sulphates, &c., per gallon, as that of certain other rivers; therefore it was stated as much purer than the average of river waters. So far as inorganic solids are concerned, both the Wolf River and the Mississippi might contain twice as much as they do without imputation on their wholesomeness, though of course they would be more impure, viewing their waters from the chemical standpoint. But this inorganic purity or impurity is not the point at issue in a sanitary investigation. This is not the purity with which the people who drink the water are concerned. Water which contains 10 grains of common salt per pint is chemically less pure than that which contains 2 grains of strychnia in the same quantity. But the sanitarian and the people are concerned about the quality of the dissolved matters. The common salt in the one is harmless, the strychnia in the other is a deadly poison. The first, though chemically impure, is a wholesome water; the second, though containing less of solid matter, is not wholesome. These old analyses say nothing of the organic matter except what may be learned from the loss on ignition.

The purification which takes place in cisterns has been explained above as altering the water so completely that when it is drawn thus pure it is not Wolf River water. Filtration through charcoal exercises even a greater influence over the water. (See Nos. 260 and 261.) Professor Wauklyn experimented with the silicated carbon filter. He made a poisonous solution of strychnia, filtered it, and drank a pint of the filtered liquid, but he did not bring forward these experiments to prove that strychnia is not a poison, only as illustrative of the value of charcoal filtration. Nor can the purity of Wolf River water after filtration be used as an argument in favor of the wholesomeness of the natural water. It is but another illustration of the value of charcoal filtration. The only allowable inference is that Wolf River water is susceptible of purification. But so is sewage or strychnia water. That they can be purified does not prove

them pure. The people of Memphis are interested in the quality of Wolf River water as supplied to them by the water company, and not as it exists when purified by artificial means. That the water selected for the supply of a large city should be a wholesome water in its natural condition, and irrespective of any artificial treatment, is one of the first principles of hygienic science. Wholesale sedimentation or filtration will improve a fair or usable water, but it cannot be relied upon to make an unwholesome water pure. What may be done by the individual cannot always be accomplished on the large scale for the community. The Mississippi water, when at its purest, is an allowable water. The condition of the Wolf River water, when at that stage, is unknown. The experiments indicate that it is not so good as that from the larger stream. Neither is suitable for a supply at other seasons. But if better cannot be had, what is to be done? Underground cisterns furnish a pure water when they are sound and clean. But their lime lining is subject to a process of disintegration and solution. They fall into decay insidiously and become leaky. They can only be trusted to furnish a wholesome water when they are sunk in an uncontaminated soil. That of Memphis is not pure. Its cisterns should be used only until a supply of usable water is introduced from beyond its limits. If no other source is available, an attempt must be made to purify the water of one or other of the rivers so as to make it reliable at all seasons. Undoubtedly the Mississippi furnishes a water which responds more readily to treatment directed to its purification. Its sand and clay settle sooner than the clay of the Wolf River, and they do not form so impervious a stratum on the surface of a filter. But the engineering and financial difficulties which lie in the way of a Mississippi supply are said to be too great for the abilities of the present. Money is therefore being expended on the Wolf River works to improve the water supply. If the water company can furnish a supply which does not exceed .015 in its albuminoids it would be more reliable than the cistern water; and with care and money the required purification can be effected probably with the expenditure of less of each than would be required to overcome the engineering difficulties involved in a Mississippi supply of equal purity. The water at Raleigh, 9 miles above Memphis, is loaded with the same clay which contaminates the river below that point. No advantage would therefore be derived from bringing the water from that place. The same expenditures would be involved in its purification. So far as the new water company is concerned, the character of the water supply furnished will depend upon money and method. But, as the source is so frequently impure, carelessness may at any time give the city an unwholesome supply. To protect the interest of the people, the health board should have a water inspector to watch the condition of the water supply, and notify it when the albuminoid ammonia exceeds a certain figure.

Nos. 264 and 265 constitute the ice supply of New Orleans. The swamp water was taken from beyond Broad street; the sewage from the Orleans drainage canal. Urea in the latter gives excess of ammonia. The chlorine results show the proportion of animal waste in each. Carbonaceous matters are large in both. From the former, the albuminoid ammonia distilled in quantities which diminished one-half in successive distillates. From the latter it was evolved more rapidly. The nitrous trace shows oxidating influences to be active in both.

The Potomac water supply may be compared with the Wolf River samples already recorded.

The Ship Island specimen will no doubt give better permanganate results when the well is older. The sample was collected soon after the borings were made. Its sediment was small and gave no increase to the albuminoid ammonia when shaken up with the supernatant water before distillation.

SECTION XI.

ON ULTIMATE ANALYSIS AS COMPARED WITH OTHER PROCESSES.

When the writer was directed by the executive committee of the National Board of Health to examine into the water supply of certain towns and villages in the Southern States, the method of analysis to be adopted in the work required the most careful consideration. Three processes were in use by sanitary analysts for the estimation of the organic impurity in water; and each of these was warmly supported by its advocates, who at the same time questioned the results obtained by the other methods. Dr. Frankland upheld his combustion process as the only accurate method by which the organic matter could be estimated. Professor Wanklyn asserted the nitrogen estimations by combustion of the residue to be valueless, and held that the position of a given water in the scale of impurity could be more accurately defined by the amount of albuminoid ammonia distilled from it. Dr. Tidy sustained the permanganate results as more valuable than the difficult and doubtful issues of the combustion and the uncertain fractional yield of ammonia from the albuminoids. Acknowledging, however, that Dr. Frankland's process was theoretically the best, he showed that his

permanganate results agreed in general terms with those obtained by combustion, and hence claimed accuracy over Wanklyn's method and simplicity over Frankland's.

The views held by the writer were to the effect that each of these processes yielded information with regard to the sanitary value of water; that the carbon and nitrogen of the combustion process gave expression to the amount of the organic matter; that the albuminoids of vitality were similar in composition, and that the ammonia distilled from them, although failing to account for the whole of their nitrogen might be viewed as an expression of their quantity; and that the permanganate oxidations might be considered as measuring the blackening which takes place on ignation. These views rendered the first process unnecessary by substituting for it a combination of the other and simpler methods. But as the action of permanganate in the cold is slow, while a number of experiments conducted at the boiling point showed consistency in their results, the process was modified accordingly. On returning from Memphis in December, 1879, the writer was gratified to find that in the new edition of Professor Wanklyn's book he makes use of a permanganate process with an iron ending to aid his albuminoid process in estimating the quality of the water. More recently Dr. Frankland, in his treatise on the subject, acknowledges that in certain cases the permanganate affords results which are consistent with those yielded by combustion, and describes the method with the iodine measure of excess as adopted by Dr. Tidy. These concessions on the part of opposition leaders suggest that the views of water analysis herein expressed are correct.

With regard to the combustion process, the precautions which are taken to prevent atmospheric contact during evaporation show that even its advocates acknowledge the liability to error from this cause. Its opponents suggest at the same time the impossibility of evaporating a water to dryness without loss of organic elements, especially in the presence of sulphuric acid oxidized from the sulphurous by the destruction of nitrates. The error produced by loss of free ammonia in spite of the fixation by the sulphur acid is acknowledged and provided for by Dr. Frankland. Loss of nitrogen may occur in certain cases when oxygen from the cupric oxide peroxidizes nitric oxide; lastly, the whole process is susceptible to error, which, in the laboratory of the inventor, amounts to .005 part of nitrogen adventitiously introduced. The first analysis given in Dr. Frankland's book is a rain-water which contains .007 parts of nitrogen and .029 parts of free ammonia. The correction for the ammonia lost during the evaporation is .006 parts of nitrogen; that for nitrogen adventitiously introduced is .005 parts, making .013 parts of correction for error in dealing with .007 parts of nitrogen in the residue.

But allowing the nitrogen in all cases to be determined with accuracy, the interpretation of the results of the process remains to be considered. The method is tedious and requires the utmost care and delicacy of manipulation to insure success. The process when finished announces that the residue of 100,000 parts of water contained so many parts of carbon and so many of nitrogen. A sample which yields high results is of necessity charged with large amounts of organic matter, and is correspondingly dangerous. The limit of carbon and nitrogen consistent with wholesomeness has been defined with as much certainty as the unknown nature of organic matter will permit, and waters are classified as good, usable, or wholesome in accordance with the carbon and nitrogen figures. But there is nothing absolute in all this. The elementary determinations merely show the position of a given water in the relative scale so constituted.

It is claimed by Dr. Franklandthat the ratio of carbon to nitrogen will indicate, in surface waters at least, whether we are dealing with animal or vegetable organic matter. In the former the carbon is to the nitrogen as 3 or more to 1; in the latter as 4 or more to 1, "If the proportion be as low as 3:1, the organic matter is of animal origin, if it be as high as 8:1, it is chiefly, if not exclusively, of vegetable origin. Between these proportions the analyst must be guided in his opinion by the knowledge of the surroundings and of the source of the water, &c." It is thus conceded that there is a large number of cases where the ratio of the elements is of no value in this connection; and this number is largely increased by the changes which are going on in the water. The formation of carbonic and nitric acids and ammonia eliminates both the elements, and while carbon is thus entirely lost to the ultimate analysis, ammonia may or may not remain to add to the amount of nitrogen. The original ratio is changed by the process of oxidation, so that the albuminoids of vegetable matter persisting after the oxidation of carbonaceous substances may give a ratio indicative of animal origin. Besides this, the existence of a natural water in which animal or vegetable matter exists alone may be questioned. The use of the microscope authorizes this statement, irrespective of such theoretical considerations as the general diffusion and mutual dependency of the two forms of matter. A water which contains a dangerous infilterage of animal waste may be so loaded with carbonaceous matters of harmless quality that its vegetable character alone would be inferred from the ratio. Take, for instance, a leaky Memphis cistern containing water shed from a shingle roof and contaminated by the neighboring vaults. Here deposited carbon from the roof and carbonaceous mat-

ters from the wood obscure the animal nature of the dangerous contamination. Since the ratio of the elements yields no trustworthy evidence and the results of the combustion form simply a scale of relative impurity it is doubtful if the information furnished repays the time and care expended on the experiment.

An essential part of Dr. Frankland's method consists in the determination of the nitrites and nitrates which are viewed as formed from the nitrogen of animal waste and as constituting the "skeleton of sewage." The value of these products of the oxidation of nitrogen has already been discussed. They are the remains of former contamination but have no bearing on the present wholesomeness of the water, unless the proximity of the organic matter from which they are derived can be deduced from them or from some other part of the investigation.

The argument on which Dr. Frankland bases the animal nature of the organic matter in which these originate is by no means clear. Nitrates are formed from vegetable nitrogen as well as from animal albuminoids. Nor is it clear why these salts should be elected to represent the "previous sewage or animal contamination" of a water. They are liable to decomposition. The chlorides of sewage are more characteristic of animal waste than the nitrates which may or may not be formed from it. They are also more permanent. If it is necessary to estimate previous sewage, the chlorine is more reliable as a measure; but we are not concerned with the geologic history of a water, the chlorine, nitrites, nitrates, and ammonia are only of interest to the analyst as throwing light upon *recent* passages in the course of a water supply.

The permanganate process which is substituted in the foregoing analyses for the carbon determinations of the combustion method, is sufficiently accurate for our sanitary purpose. A relative scale of impurities can be formed by it and the position of a given water assigned as satisfactorily as by the ultimate analysis. The uncertainty as to the character of the matter with which we are dealing renders scientific accuracy in the determination of the carbon unnecessary. The volume of oxygen required by the organic matter in its destruction by a given method gives as clear a view of the unknown organic material as the volume of carbonic acid produced by its combustion. The shortcomings of the process have already been alluded to and illustrated.

Professor Wanklyn's method of rating the water by the ammonia and albuminoid ammonia which can be distilled from it does for the nitrogen what the permanganate does for the carbon. It gives a view of the unknown albuminoids in the water as satisfactory after its kind as that furnished by the total nitrogen of the actual combustion. Its failure in certain cases to indicate contamination has been pointed out. The vegetable character of an organic matter may be inferred from the excess of oxygen required as compared with the organic ammonia, certainly with as much probability as from the ratio of organic carbon to organic nitrogen. An infusion of sawdust gave .045 mgrm. of albuminoid ammonia and required 8.137 mgrms. of oxygen, which is equivalent to stating that the carbon was greatly in excess of the nitrogen. Albumen from blood gave .480 of organic ammonia and required only 3.399 mgrms. of oxygen. But the history and surroundings of the water, the quantity of chlorine, and the microscopic appearances of the sediment must be carefully studied to arrive at an opinion on the probable quality of the organic matter.

In view of these considerations, it is believed that the method adopted in the foregoing analyses will meet with the approval of those who have carefully studied this sanitary problem.

APPENDIX N.

SANITARY SURVEY OF SELECTED PORTIONS OF THE CITY OF BALTIMORE, MD.

By Dr. C. N. Chancillor.

CORRESPONDENCE RELATING TO AND REPORT UPON A SANITARY SURVEY OF A PORTION OF THE CITY OF BALTIMORE, MARYLAND.

Health Department, City Hall,
Baltimore, February 6, 1880.

Dear Sir: I have the honor to inclose to you resolutions which, in pursuance of the action taken at the meeting of yesterday, were laid before his honor Mayor Latrobe this morning and by him transmitted to me to be forwarded to you.

Very respectfully, yours, &c.,

JAMES A. STEUART,
Commissioner of Health.

Dr. J. S. Billings, U. S. A.,
Vice-President National Board of Health, Washington.

Resolved, That the National Board of Health, in conjunction with the State and city boards of health and the physicians in charge of the quarantine hospital, be, and they are hereby, respectfully requested to communicate in writing to his honor the mayor of Baltimore, through the board of trade of Baltimore, their views and opinions as to the necessity for the establishment of additional quarantine facilities for the port and city of Baltimore, together with their recommendations for a proper location of the same; and that, on the receipt of such communication, his honor the mayor be requested to urge the city council to take immediate steps to carry out and perfect such recommendations.

Resolved further, That the same gentleman be requested to give their views as to a proper system of drainage and sewerage, or otherwise, for the city of Baltimore, in order to protect and guard against epidemic or contagious diseases; and that, on the reception of the same, his honor the mayor request the city council to authorize the appointment of a commission of medical experts to devise and recommend a suitable plan or to take such other steps as in his judgment is most advisable to insure the city from the creation or spread of epidemic diseases.

[Extract from minutes of a meeting of the executive committee of the National Board of Health, dated February 6, 1880.]

The vice-president stated, in connection with the letter of Dr. Steuart, that the president and himself had, in accordance with previous understanding with the executive committee, visited Baltimore yesterday (5th), and, meeting the quarantine officer of the port, the health officer of the city, the secretary of the State board of health, the president of the board of trade, and others, had gone down the river, looked at various points in connection with the quarantine, and, returning, had an interview with these gentlemen, as well as with the mayor of the city, during which the question of the quarantine, sanitary condition of Baltimore, and the necessity for sewerage was discussed by members of the State and local boards of health, the collector of the port, and others; that the meeting was informally organized with the mayor in the chair; that a motion made by Mr. Thomas, the collector, was adopted, to the effect that the National Board of Health or its executive committee be requested to state to the mayor of Baltimore their views in regard to the quarantine and sanitary condi-

tion of the city of Baltimore and the necessity for sewerage; and that an amendment was subsequently adopted asking the State board of health and health officer of the city to join in the statement. After some discussion the following resolutions were adopted by the committee:

"Whereas his honor the mayor of Baltimore, and other gentlemen representing the varied commercial interests of that city, have signified their wish to have a written expression of the views of the National Board of Health as to the sanitary advantage likely to be gained by a removal of the quarantine station in the harbor of Baltimore from the present locality to a point some miles lower down the river; and also as to the desirability and importance of immediate action by the city and State government looking to the establishment of a complete system of sewerage as a means of improving the sanitation of the city and of anticipating troubles which may be expected to arise from a continuance of the present mode of disposal of its excremental filth; and whereas two members of the National Board of Health, having visited Baltimore, and having held a conference with the said parties and with the health officers of the State and city, after a personal inspection of the present quarantine station and of other points in the river, with a view to said removal, have reported to the executive committee the facts which came under their cognizance and the opinions expressed by the authorities of Baltimore: Therefore,

"*Resolved*, 1st. That this committee consider that the continuance of the quarantine station of Baltimore at its present site is fraught with danger to the sanitary interests of that city, both because of its close contiguity to the pest-house, which is established on the quarantine grounds, and of the danger of communicating disease from infected ships in quarantine to other shipping entering or leaving the port, and that in view of these facts the removal of said quarantine station to a point not nearer to the city than the Little Hawkins or Leading Point, where there may be adequate facilities for complete isolation, seems indispensably necessary, while the pest-house should be retained at its present location as more accessible to the city, where small-pox is more likely to originate, and as being sufficiently remote from the proposed quarantine station.

"2d. That in order to secure, as far as practicable, harmony of views and uniformity of action as to rules and regulations for the treatment of vessels believed to be infected or coming from infected ports without clean bills of health from United States consular officers, the National Board of Health having last summer drawn up a set of such rules and regulations to meet the then existing emergency, being assisted in the performance of such duty by the quarantine authorities of New York and Baltimore, now propose, as intimated in its annual report (supplement to Bulletin, p. 3), to 'revise these rules after consultation with the State and local authorities, who have had experience as to their practical operation,' and does hereby invite the quaran-officer of Baltimore to assist in such revision.

"3d. That this committee considers a complete system of sewerage for the removal of excremental filth indispensable to the preservation of the public health in the city of Baltimore, and heartily indorses the recommendations on the subject contained in the last biennial report of the secretary of the State board of health of Maryland.

"4th. That this committee respectfully recommends to his honor the mayor that steps be taken, as soon as practicable, to have made—1st, a topographical survey of the city by competent engineers, in order to prepare accurate countour maps showing the levels and the best outlet point for such sewerage; 2d, a sanitary survey, as distinct from such topographical survey, and connected with a careful house-to-house inspection, in order to determine the existence and magnitude of any sanitary evils which should be remedied.

"*Ordered*. That copies of the foregoing resolutions be furnished to the different gentlemen before mentioned as having requested this expression of the views of the National Board of Health, accompanying the same with a letter, in which any additional explanation thought necessary may be made by the president."

WASHINGTON, D. C., *February* 6, 1880.

DEAR SIR: In accordance with the request of the meeting held at Rennert's Hotel yesterday afternoon, at which you presided, I have the honor to transmit the inclosed preamble and resolutions adopted this morning by the executive committee of the National Board of Health, which have been submitted to the health authorities of the State of Maryland and of the city of Baltimore for their concurrence.

It is earnestly hoped that the proposed improvements will be commenced at as early a period as may be possible.

Very respectfully, your obedient servant,

J. L. CABELL,
President National Board of Health.

General F. C. LATROBE,
Mayor of Baltimore, Md., &c.

[Extract from executive minutes of February 27, 1880.]

Ordered, That the request of the city of Baltimore, when received from the mayor, be referred to the president of the Board, with a request that he will visit Baltimore, confer with the State and local health authorities, and report to the committee his recommendation in the matter.

MAYOR'S OFFICE, CITY HALL,
Baltimore, March 5, 1880.

To the President and Members of the National Board of Health :

GENTLEMEN : I have this day received a certified copy of a resolution passed by the city council of Baltimore, a copy of which I herewith inclose, by which I am authorized to invite the National Board of Health to institute and conduct, under its auspices, a sanitary survey of the city of Baltimore, or such portions of it as they may deem necessary.

I have the honor to request that your board will make such a survey as is indicated in the resolution referred to.

Very respectfully,

FERDINAND C. LATROBE, *Mayor.*

Whereas the National Board of Health has expressed the opinion that a sanitary survey of Baltimore is important in the interest of the future health of the city: Therefore,

Be it resolved by the first and second branches of the city council of Baltimore, That his honor the mayor be, and he is hereby, requested to invite the National Board of Health to institute and conduct, under its auspices, a sanitary survey of the city, or such portions of it as they may deem necessary.

NATIONAL BOARD OF HEALTH,
Washington, D. C., March 8, 1880.

SIR : I have the honor to acknowledge the receipt of your communication of the 5th instant, transmitting copy of a resolution of the first and second branches of your city council inviting the National Board of Health to make a sanitary survey of your city, and to state that the papers have been referred to the executive committee of this Board.

Very respectfully,

T. J. TURNER,
Secretary National Board of Health.

Hon. F. C. LATROBE,
Mayor of Baltimore, Md.

NATIONAL BOARD OF HEALTH,
Washington, D. C., April 8, 1880.

SIR : In compliance with the request contained in a resolution of the city council of Baltimore, transmitted to this Board in your communication of March 3, the executive committee has this day appointed Dr. Charles W. Chancellor a special sanitary inspector to be assigned to the duty of making a sanitary survey of selected portions of the city, and has instructed me to communicate this fact to you, and to request that you will give to Dr. Chancellor, in conjunction with the health commissioner of the city, who has been requested to co-operate with him, such facilities and such authority as may be needed to enable them to have entrance to and make the necessary inspections.

I take occasion to recall to your remembrance the statement I made to you in a personal interview to the effect that it is entirely beyond the scope of the power of this Board to extend pecuniary aid to States or municipalities for purposes of local sanitation. It is therefore not with any view of relieving the city of Baltimore from any part of the expense of improving its sanitary condition that the partial survey about to be instituted under the auspices of this Board has been ordered by the executive committee. It is done in conformity with the provisions of the law to obtain accurate data on which the advisory function of the Board can be intelligently exercised and enforced, with the expectation that the work will be followed up by the authorities of the city to its proper conclusion.

Very respectfully, your obedient servant,

J. L. CABELL,
President National Board of Health.

General F. C. LATROBE,
Mayor of Baltimore.

NATIONAL BOARD OF HEALTH,
Washington, April 8, 1880.

DOCTOR: I am directed by the executive committee of the National Board of Health to inform you that, having decided to comply with the request of the city council of Baltimore as transmitted by his honor the mayor in a communication dated March 5, addressed to this Board, it has this day appointed you a special sanitary inspector, to be assigned to the temporary duty of making a sanitary survey of selected portions of the city in conjunction with Dr. Steuart, health commissioner, so far as he may be willing to extend assistance in the way of counsel and co-operation.

You are accordingly instructed to call upon those officers and to request in behalf of this Board that they will offer you every facility in their power to enable you to perform satisfactorily the important duty which has been assigned to you. To this end I inclose a letter addressed to General Latrobe, which makes known the wishes of the Board and solicits his official co-operation. This open letter you are at liberty to read before delivering it to the mayor.

The selection of the localities to be inspected is left to your discretion after conference with Dr. Steuart, but it is suggested that the inspections should not be confined to the localities which are manifestly in the worst sanitary condition. It may be important to show that even some of the apparently best parts of the city are not exempted from dangers under the system which has heretofore prevailed of disposing of excremental filth. It is the desire of the Board that the partial survey now ordered shall demonstrate to the satisfaction of the council the imperative necessity of a general system of sewerage of Baltimore.

It is suggested that you invite the special attention of the authorities of the city to a report in the Baltimore Gazette of Thursday, April 8, of four deaths from scarlet fever in three days, with two more children dying in the same house, No. 340 East Madison street, and of the probable local cause of this great mortality as ascertained by sanitary inspection.

It is requested that in making house-to-house inspections you will use the schedules of questions contained on the blank forms which have been furnished you, but that you will also collect any other information which may be pertinent to the general objects of the survey.

The amount appropriated by the Board to be expended under your direction for this survey, including your own pay of $10 per diem while actually engaged in the performance of your duties, is strictly limited to $700. The committee feels assured that you will disburse the amount placed under your control with the utmost economy, so far as may be consistent with the attainment of the ends had in view, and that for every dollar expended there shall be an adequate service rendered.

You will certify to the correctness of all accounts forwarded to this office for settlement on forms of vouchers which will be furnished you on demand.

Very respectfully, yours,

J. L. CABELL,
President National Board of Health.

Dr. C. W. CHANCELLOR,
Baltimore, Md.

NATIONAL BOARD OF HEALTH,
Washington, September 30, 1880.

SIR: Referring to my communication of April 10, announcing the appointment by the executive committee of the Board of Dr. C. W. Chancellor as a special sanitary inspector to be charged with the duty of making a sanitary survey of selected portions of Baltimore City in compliance with a request to that effect by the city council, I have now the honor to inform you that said survey has been made in conformity with instructions from this office, and to transmit to you Dr. Chancellor's report of the same. It is pertinent to remark that Dr. Charles F. Folsom, then secretary of the State board of health of Massachusetts, who had made a special study of the methods of sewerage and disposal of the excremental filth of cities both in Europe and in this country, was appointed by this Board to consult with Dr. Chancellor in the progress of his work and in the preparation of his report, in the general conclusions of which he has expressed his concurrence. I avail myself of the occasion to say that the facts cited in this report abundantly justify the opinions expressed in the preamble and resolutions adopted by the executive committee February 6, 1880, which having been submitted to the health authorities of the State of Maryland and the city of Baltimore, and having received their concurrence, were transmitted to you as chairman of a meeting held at Rennert's Hotel on the preceding day, at which meeting a resolution was passed soliciting such expression of opinion on the part of this Board. I will add that, while the executive committee earnestly reiterates the advice then given, proper steps be *immediately* taken looking to the inauguration of a systematic sewerage of the city

of Baltimore as an indispensable means of protecting the public health, it concurs with Dr. Folsom in thinking that it would be premature to recommend any particular plan until there shall have been made by competent engineers an exact topographical survey of the city, with contour-maps, in order that the problem of the carriage and final disposal of the sewage of the entire city on some uniform plan may be intelligently considered.

Very respectfully, your obedient servant,

J. L. CABELL,
President National Board of Health.

Hon. F. C. LATROBE,
Mayor of Baltimore.

REPORT.

PART I.

TO JAMES L. CABELL, M. D.,
President of the National Board of Health, Washington, D. C.:

SIR: According to instructions received from you on the 8th day of April, 1880, I immediately proceeded to make house-to-house inspections of selected portions of Baltimore, with the view of determining, if possible, the sanitary needs of the city. In this work I have been most efficiently aided by the police department. A number of their most intelligent officers were detailed to make preliminary inspection, which they did in a thorough manner, thereby greatly facilitating the investigation.

In collecting the data upon which this report is based, as well as in the preparation of the same, I am also indebted for valuable assistance to Major Richard Randolph, civil engineer, who gave special attention to all questions involving engineering problems.

A COMPREHENSIVE INSPECTION NEEDED.

It is to be regretted that the inspection could not have been more comprehensive, so as to have enabled us to determine the actual sanitary condition of the entire city, instead of embracing only those districts which were regarded as presenting a specially good field for observation. A careful examination of the facts collected, however, will furnish a reliable basis for sanitary reasoning on several points of the most important character. They relate to seven out of twenty wards of the city, and may be summed up as follows:

FIRST DISTRICT.

Second Ward.—Embracing portions of Broadway, Thames, Ann, Fell, Wolf, Block, Philpot, Lancaster, Bond, Dallas, Caroline, Register, Durham, and Aliceanna streets. In this district, which embraces what is known as the typho-malarial district, 547 houses were inspected, containing a total of 3,653 inmates, or an average of about 6¼ persons to a house. In quite a number of instances, however, this average does not properly represent the real condition of things, and, as will be shown further on, there are not a few cases of overcrowding. In 130 of these houses, pumps are used to supply the inmates with water, which is represented to be "bad" or "not very good" in many instances. Seventy-four houses are without any special water supply, which doubtless means that their inmates make use of some convenient pump. The remaining houses are supplied with hydrant water. Of the privies, 118 were found to be in bad condition, and many of these were overflowing, saturating the ground with their liquid contents, polluting foundations, and occasionally flooding cellars with stagnant and offensive fluids. The smell from many of these cess-pools was extremely noxious. Of the whole number, only 30 are self-draining; the remainder are said to be cleaned once, twice, or three times a year. The great majority are not cleaned oftener than twice, while many are not emptied oftener than once annually. In the case of 85 houses inspected on South Bond, South Dallas, South Caroline, Lancaster, and Thames streets, the greatest depth of privies was found to be 40 feet, while the minimum and ordinary depth was only 6 feet; the maximum distance from the house is 90 feet, while in many cases the privies are attached to the sides of the houses or within 2 or 3 feet of them, and discharge their offensive effluvia through open windows or doors into the sleeping or sitting apartments. Some of the lots have, at different times, had as many as five privy vaults, which, after becoming full, have been successively abandoned for a new vault, or rather for another hogshead, it being found cheaper to cover over the full cess-pool and sink a fresh pit or hogshead than to empty one that has already become full. In this way the ground space of a number

of lots has been literally honeycombed by a succession of privy-pits, which, after being filled with decomposing excrementitious matter, are covered over and abandoned. It needs no elaborate argument or expert knowledge to prove that malarial poisons are being constantly generated and brought to the surface, to contaminate the surrounding atmosphere with their baleful influences. In 256 houses in this district there are no cellars, and, in most cases, no ventilation beneath the ground floor; in 23 instances the cellars were found damp and in bad condition, filling the air with their foul odors.

SECOND DISTRICT.

Fifth ward.—Embracing portions of Jefferson, McEldry, Monument, Asquith, and Central Avenue streets. The number of houses inspected in this district was 281, containing a total of 1,515 inmates. All the houses in this district, with the exception of four where pump water is used, are supplied with water from the regular city supply. One hundred privies were found in bad condition. Only 33 are self-draining; the others are represented to be cleaned once or twice a year. Seventy-one houses are without cellars, while 76 were in bad condition, and quite a number contained filth and offensive fluids which could not be drained off. The portion of Asquith street embraced in this inspection presents an excellent example of the superiority of deep wells over shallow privy-pits. For instance, in 41 houses inspected, in this particular locality, all the privies that are not self-draining require to be emptied three or four times annually to prevent their getting into a state of nuisance, and even with this precaution they constantly emit noxious odors, while the deep wells were found generally clean and free from any decidedly bad smell. The latter, being self-draining, seldom require cleaning; but there are sanitary evils of very great gravity connected with the deep-well system, which will be hereafter fully considered.

THIRD DISTRICT.

Sixth ward.—Embracing portions of Orleans, Broadway, Bethel, Bond, Jefferson, Central Avenue, North Caroline, North Dallas, McEldry, North Eden, and North Spring streets. In this district 452 houses were inspected, containing a total of 2,392 inmates, or an average of about five persons to a house. The water supply is derived from the city works, except in fourteen instances, where pumps are used. One hundred and eight privies were found in bad condition, many of them overflowing and completely saturating the surrounding soil. Twenty-five of the entire number are self-draining, and all the rest require frequent cleaning, their usual depth being about 4 feet. In many cases they are close to or actually attached to the sides of the houses. Seventy-six houses inspected have no cellars, and in 56 of those having cellars they were found damp and filthy, and, in a few instances, flooded with stagnant fluids. Twenty-nine yards were in bad condition, a few very filthy, containing ashes, garbage, and house-refuse of every kind. In the case of 23 houses on Jefferson, Central Avenue, and Orleans streets, and in the case of 16 houses on Eden street, the Harford Run sewer passes through or very near the premises, creating a disgusting nuisance, revolting alike to decency and to health. In not a few instances this open, disease-engendering drain passes directly under the floors of houses, affording free entry of sewer gases into dwelling and sleeping apartments. The positive dangers of these gases cannot be overestimated, and the public mind cannot be too soon aroused to the fact that any one in the neighborhood of this filthy drain may be the next victim to the effects of its poisonous emanations. It is not only a possible, but a very probable, source of danger, which should be removed without delay. A large appropriation has already been made by the city for the purpose of arching, covering, and diverting this stream at specified points, and now no delay should be permitted in the accomplishment of a work which is of the highest sanitary importance. The remarks made on this subject in my last report to the State board of health may be with propriety repeated here: "In many respects Jones's Falls and Harford Run bear the same relation to Baltimore that Bayou Gayoso does to Memphis; and unless their sanitary condition is improved, they may, at no distant day, excite a malignant fever in our midst which will sweep off thousands of citizens, and, for the time, paralyze the whole business of the city. As long as the accumulation of filth in those streams is covered by water no injurious consequences will probably result; but should the quantity of filth be increased so as to rise above the surface of the water, the most dreadful consequences may be anticipated."

FOURTH DISTRICT.

Sixth and Seventh wards—Embracing 350 houses on Central Avenue, Monument, Milliman, Spring, Caroline, Dallas, Walker, Boundary Avenue, McEldry, Joppa, and North Bethel streets, with a total population of about 2,500 human beings. Ninety per cent. of the houses inspected in this district had shallow privy-vaults, not more than 5 feet

in depth as an average, and located some in proximity to and others from 1 to 10 feet distant from the dwellings. Fifty per cent. of these vaults were in bad condition, and many were full to overflowing, while nearly all needed cleaning; most of them emitted offensive smells, and only one of the entire number was self-draining. There were stables and manure-pits on 14 premises, which were generally in bad sanitary condition, some of them draining into alleys and streets and upon adjacent property. A large majority of the houses in the district are supplied with water from the city water-works. About 75 houses were without cellars, while the remainder were provided with cellars, many of which were damp and dirty, and a few offensive to smell. In several instances privy-vaults existed in the cellars, and in one house, notably, the privy adjoined the house and poured its noxious gases through a window into a damp, dirty cellar, which was very offensive.

FIFTH DISTRICT.

Seventh ward.—Embracing portions of Caroline, Dallas, Bond, Broadway, Chew, Monument, Milliman, Eden, Spring, Madison, Miller, and James streets, and Somerset alley. Three hundred and fifty-six houses were inspected in this district, containing a total of 3,108 inmates. Nine families are supplied with water from pumps; the remainder are supplied from the city water-works. Of the privies 203 were found in bad condition, many of them being full and others overflowing. Thirty-seven are self-draining, and the rest *profess* to be cleaned once or twice a year. A large number of these privies drain or empty directly into Harford Run. Out of 23 houses inspected on Spring street, the Harford Run sewer may be said to bear the relation of a positive nuisance in 16 cases. It is a nuisance in the case of 8 houses out of 22 at one point on Caroline street, and 9 houses out of 10 between Nos. 129 and 147 Spring street. The condition of the cellars and yards in the vicinity of this sewer indicates clearly what must be its influence sooner or later upon the health of the neighborhoods through which it flows. Fifty-eight cellars were found damp and in bad condition in this district, and the dampness existing in those on Spring street is directly traceable to the proximity of Harford Run. One cellar was not only damp, but actually flooded with foul water from this source. At one point on Spring street there is also a tannery, which emits a noisome smell, and its vats empty their contents directly into the run, adding another element of filth to its already black and offensive flow.

The character of a very large proportion of the diseases which have prevailed in this district indicates that the condition of Harford Run has already begun to influence in a very marked degree the health of those subjected to its seething and poisonous exhalations. This badly constructed and disgracefully filthy drain is undoubtedly the principal cause of a majority of the cases of sickness reported, and however energetic our State and city health departments may be in the performance of their respective duties, they cannot begin to enforce the requisite amount of sanitation to protect the public from these insidious and ever-pervading poisons. Their means are limited, and in the case of the State board of health their power is simply advisory.

SIXTH DISTRICT.

Eleventh ward.—The sanitary survey of a portion of this ward, which is situated in the higher and better part of the city, and contains, generally, only dwellings of the better class, embraced 118 houses, containing a total of 733 inmates, or an average of about six persons to a house. The cellars, yards, &c., of all these houses were found in good condition; water-closets in nearly every house, which are emptied by trapped soil-pipes into a well in the yard. Sixty-four of these wells are self-draining; the remainder are cleaned as often as may be required. The supply of water in every house is derived from the city water-works.

SEVENTH DISTRICT.

Eighteenth and Nineteenth wards.—Parts of each of these two wards were inspected, but as there was nothing of special interest in a sanitary point of view observed, it is not deemed necessary to enter into a detailed account of the inspection. As in the sixth district, a very large proportion of the privies are self-draining and for the most part exceptionally clean, as were also the cellars and yards.

Notwithstanding the fact that the privy-vaults in this and other high-lying districts are usually self-draining and very generally in excellent condition, the great importance of avoiding all sources of unwholesome and offensive effluvia, and of preserving the substrata of the city in a dry and clean condition, creates a severe necessity for relinquishing altogether these cess-pools, which can only be done by establishing a proper system of sewerage.

OVERCROWDED HOUSES.

Apart from the general conclusions to which we are led by the data from the several districts referred to above, even the partial inspection which has been made shows the existence of several serious evils in this community: prominent among them is that of overcrowded dwellings. Happily this evil has not yet attained the proportions in Baltimore which it has reached in other cities, but from the following instances it will readily be perceived that a foundation, at least, for the tenement-house system has already been laid in our midst. No. 73 Lancaster street is reported as being occupied by five families of 19 persons; No. 75, same street, contains five families of 18 persons; No. 100 Thames street, only 28 by 60 feet, with lot 28 by 30 feet, is occupied by five families of 34 persons; No. 128 Thames street contains three families of 16 persons; No. 253 Ann street, house 20 by 60 feet, has six families of 24 persons; No. 289 Ann street, house 18 by 70 feet, has six families of 37 persons; No. 290, same street, has five families of 18 persons.

Quite a number of other instances of overcrowding were noticed, and it seems probable that a thorough inspection of the whole city would reveal many more. The importance of securing comfortable and commodious accommodations for our laboring classes can scarcely be overestimated, but after the tenement system has once been fastened upon a large community, it is not an easy matter to sweep it away. Where it already exists to a large extent, as in New York, it can only be gotten rid of by long and patient effort; but there would seem to be no good reason why, in the case of a city like Baltimore, where the evil is still in its incipiency, it should not be forestalled by the efforts of an enlightened public spirit and philanthropy. Such an evil is as apalling in its moral as in its physical aspects. There is a fixed relation between comfort and morality. The man who comes home tired and exhausted wants quiet and comfort; if he finds filth, squalor, and discomfort in every shape around him, he naturally gets away from them and seeks selfish gratifications in the beer-shop, the brothel, or wherever they may be found. Virtue and vice are as dependent upon physical conditions as health and disease. "In these wretched dwellings," writes John Kay, of the tenement houses of London, "all ages and sexes—fathers and daughters, mothers and sons, grown up brothers and sisters, stranger adults—males and females—and swarms of children; the sick, the dying and the dead are huddled together with a proximity and mutual pressure which brutes would resist; where it is physically impossible to preserve the ordinary decencies of life, where all sense of propriety and self-respect must be lost, to be replaced only by a recklessness of demeanor which necessarily result from vitiated minds."

Conceive the morality of those who are "cribbed, cabined, and confined," all the grades of low humanity together, as occurs in some of the dwellings on Thames, Lancaster, and Ann streets, in Baltimore. In one small house, with a superficial area of only 18 by 70 feet, thirty-seven men, women, and children are huddled together in misery and squalor! Under such circumstances, health not less than virtue is impossible. What says George Godwin, a philantropist who has seen as much of the horrors of town shadows as most men? "Again and again would we assert that as you lead men and women to appreciate cleanliness, light, air, and order, you make them better citizens, increase their self-respect, and elevate them in the social scale. By the miserable dwellings to which thousands in our great cities are condemned we are impelling them downward—an easy process—with frightful results. *It cannot be too often repeated that the health and morals of the people are regulated by their dwellings.*"

THE COST OF SICKNESS AND DEATH.

It is no very difficult thing to prove that every death caused by the want of proper social measures must be a loss to the community, and that all unnecessary sickness, requiring the expenditure of money to cure it, must also be a loss; pauperism, we know, is often increased by the untimely death of those who support families, and, as a consequence, there is an increased expenditure of the public money. It is not because there is a difficulty in proving these truths that their influence has been so little marked, but it is because men have so rarely thought of them. Let it be remembered that a sickly population is one of the most costly burdens of a state. "Health is a poor man's capital in trade, and whatever deteriorates that entails a direct loss and eventually a heavy money charge upon the community." The enormous amount of poverty in this country, as in most of the European countries, and the consequent necessity of expending millions of dollars annually for its relief, are in a great measure due to the pauperizing effects of preventable diseases. It has been stated that the money lost through yellow fever alone, by the city of New Orleans, during the epidemic of 1878, was nearly $20,000,000. To this add the loss sustained by other communities from the same epidemic, estimated at $175,000,000, and say whether the amount is not worth trying to save.

NEGLECT OF SANITARY LAWS.

A glance at the condition of affairs in the several districts inspected shows an alarming degree of indifference or negligence in the observance of sanitary laws in the city of Baltimore; and especially would this seem to be the case with reference to the empyting and purifying of privies. In the older parts of the city the primitive privy is almost universally used, and only in a few instances are they self-draining; they are generally simply a shallow pit from 4 to 6 feet in depth, which, in many instances, has to serve the purposes of from 10 to 20 persons. A moderate regard for health and cleanliness would suggest the emptying of these places at least three times a year, but as a general rule they are emptied only once or twice annually. The result, as already shown, is that they very often overflow, saturating the surrounding ground with their disease-breeding contents, and probably sowing the seeds of some terrible epidemic. The danger involved in this state of things is heightened by the fact that these privies have, in many cases, been in use for many years, and the earth around and beneath them has become so saturated with their foul contents that it no longer has any power or virtue as a deodorizing or disinfecting agent. They can, therefore, only be regarded as store-houses of disease, and the sooner they are superseded by an enlightened system of sewerage the better it will be for the future health of the city.

PROVISIONS OF THE CITY CODE.

The Baltimore City Code, article 23, section 79, provides that "all privies that are liable or likely to get into a state of nuisance between the 1st day of June and the 1st day of October shall be well cleaned between the 1st day of October and the 1st day of June, and it shall be the duty of the board of health to cause to be made, through the commissioners of police and the force under them, between the 1st and 10th of each June, a thorough inspection of all privies, wells, or vaults within the city, and all that then may be found to be full, or within 18 inches therefrom, shall be deemed in a state of nuisance, and the owner or owners, agent or agents of the property to which the privy or privies respectively may belong shall forfeit and pay $20."

Section 75 clothes the city board of health with full authority "in all matters relating to the opening and cleaning of privies and vaults;" and section 84 provides that "if any person or persons shall erect, or cause to be erected, any privy or other building over any wharf or wall, or over the bed of Jones' Falls, or Harford, Shroeder's, or Chatsworth Runs, or suffer the contents of any privy to flow into the aforesaid streams, by means of a sewer or otherwise, within the limits of the city, so that the filth therefrom be discharged into the said falls, or either of said runs, such person or persons shall forfeit and pay, for each and every such offense, the sum of $20."

As is quite evident from the facts already given, these provisions are not very strictly enforced; indeed, it would seem to be impossible for the board of health, with their present facilities, to keep that watch and ward over the matter that the law contemplates. To require the police to make the inspections spoken of is pratcially to nullify this provision of the code. The members of the force have already to play the part of men of all work, and to carry out this system of inspection properly would require an independent corps of assistants to inspect, not once a year, but quarterly, every privy, and report their condition to the health department. There is a crying and imperative demand for reform in this matter.

A SANITARY PARADOX.

Generally throughout the city pumps have been discarded, and the safer water supply by the city has been substituted. But there are still many instances in which pump water is used for drinking and domestic purposes. In the first district, second ward, pump water is used on from 130 to 200 premises, and the comparative immunity of the people from disease, under the most trying sanitary conditions, is extremely remarkable, but should not lead to the conclusion that filth and bad water are conducive to health. Several instances of remarkable health under the worst sanitary conditions possible may be mentioned in this connection. House No. 60 Philpot street, 20 by 50 feet area, contained seven families of 18 persons; the privy and premises, generally, were in very bad condition, and the supply of water was drawn from an old pump, but in spite of these facts no sickness or death had occurred among the inmates for more than twelve months. No. 51 Thames street, eight families of 29 persons, cellar damp, sewer closed up, forming a cess-pool with offensive smell, privy in filthy condition, water supply good. No sickness during the year. No. 103 Lancaster street, four families of 16 persons, house 15 by 18, no cellar, privy in bad condition, pump water used, said to be "bad;" the only case of sickness during the year was a case of consumption. No. 115 Lancaster street, three families, 9 persons, pump water represented to be "very bad," but the only case of sickness reported was a single case of consumption.

Many other examples of the same character might be cited, which go to show how much the human constitution is often capable of enduring, when subjected to influences capable of producing sickness and death. But no one can doubt that should some sudden epidemic spring up in the city, those unfavorable sanitary conditions would be terrible and fatal helpers of its progress.

DANGERS OF PUMP WATER.

One of the most dangerous characteristics of pump water in cities is that often when thoroughly contaminated with the noxious drainage from adjacent privies it fails to show any sign of contamination and apparently maintains its original purity unimpaired. The mere fact, however, that it has no bad taste and retains a sparkling and clear appearance is no evidence of positive purity. Even a chemical analysis will not always discover the true character of water, and we have the authority of Mr. John Simon, formerly chief medical officer of the privy council of England, for saying that the findings of chemical tests are not entitled to unlimited confidence. "Chemical demonstration of unstable nitrogenous compounds in water," he says, "is a warning which, of course, should never be disregarded; but till chemistry shall have learned to identity the morbific elements themselves, its competence to declare them absent in any given case must evidently be judged incomplete, and waters which chemical analysis would probably not condemn may certainly be carrying in them very fatal seeds of infection." The only safe course, therefore, in large cities would seem to be total abstinence from pump water, about the safety of which there must always be, at least, a doubt in such cases. Perhaps it is worthy of consideration whether cities might not properly and legally, in the exercise of their powers for the protection of the public health, prohibit the use of pumps absolutely, whether they be on the public thoroughfares or on private property.

NEGLECT OF SANITARY MEASURES.

In the second district, where the typho-malarial endemic of 1876 prevailed with such frightful fatality, pump water is still used by many families; and open cess-pits, so constructed that their contents drain into and ooze through the soil, continue to be the only depositories for excretal sewage, the volatile products of which engender influences most prejudicial to health; while the "slops" or refuse water from domestic operations flow into and pollute the gutters. The same condition of things, in a more or less marked degree, may be said to exist in other sections of the city, and it is no less surprising than alarming that the public fail to be impressed with the gravity of these evils. While a disease with its dread horrors is still fresh in our minds, the importance of careful attention to hygienic and sanitary measures must be considered a public and private duty. It is a recorded fact that large cities in which fatal epidemics have raged, have been those whose sanitary requirements have been badly neglected. "The presence," says the report of the general board of health of England on "the sewage and cleaning of towns," "of impurity produced by the decomposition of animal and vegetable matter, is now established as a constant concomitant of the excessive ravages of typhus and other epidemic diseases in towns; and a proportionate exemption from such maladies has marked the removal of the sources of aerial pollutions."

It is scarcely necessary to enter into the details of the connection between defective sewerage and the propagation of disease. It is now universally admitted that the exhalations arising from putrescent matter of badly-arranged and badly-constructed cess-pools and open privies are fruitful sources of disease. Indeed, the immediate and direct cause of yellow fever may be said to be the poison generated by the decomposition of animal and vegetable matters to which a specific germ is added. The experience of every medical man goes to prove that a badly cleansed and drained district is always a fever one. A competent witness has said that, "in addition to a general disarrangement of health and an unusual liability to disease, there is one particular class of diseases which is always to be found in neglected places, viz, the class of contagious disorders." History teaches us that pestilence has always haunted the scenes of filth. The plague, the black death, the cholera, the camp, jail, and ship fevers, all have made these scenes their favorite resorts, and yellow fever, our modern pestilence, forms no exception to the rule.

Another point of importance in connection with cess-pools and open privies, with saturated soil, &c., surrounding them, is of great importance as bearing upon the supply of pure air to houses; for it is easy to perceive that, however well ventilated the apartments may be, the appliances are rendered futile from the admission of air tainted by the admixture of gases emanating from the filthy accumulations of the cess-pools and privies. There can be no doubt that the public health may be, and often is, impaired by this cause, and it is one of the sources of disease which it is absolutely necessary to remove before there can be any effectual cure. In some of the houses

examined we have seen that the cess-pools are in the cellars, and give out their exhalations from thence; others are in the yard close to a door or window, through which the noxious air is introduced throughout the whole of the house. To meet the evils of the cess-pools and privies in Baltimore, a system of sewerage is absolutely required, and instead of the connection between the water-closets and drains being optional, it should be made imperative.

PART II.

In connection with the details already given, it may not be amiss to consider generally other important sanitary problems which bear upon the future health and commercial prosperity of Baltimore.

LOCATION AND TOPOGRAPHY.

The city of Baltimore is situated on an arm of the Chesapeake Bay, into which the Patapsco River flows. The tide in its harbor has a mean range of one foot and three-tenths, and produces scarcely any movement in its waters. Two prongs of this arm extend in a northwesterly direction. One receives the stream called Jones's Falls, having a flow, at low stages, of 15,000,000 gallons daily, and which passes through the center of the city. This prong, the upper end of which is called "the Basin," and the lower end "the Harbor," affords the port for nearly the entire commerce of the city. The other prong, lying farther west, receives the stream called Gwynn's Falls, having a dry-weather flow of 10,000,000 gallons daily. This stream may be considered the natural western boundary of the city. Another stream called Herring Run, nearly equal in volume to the last, flows in a southeasterly direction, and discharges into another arm of Chesapeake Bay to the east, called Black River. This stream may be considered the natural eastern boundary of the city.

Between these two prongs is inclosed a peninsula with two points—the eastern one being the site of Fort McHenry, the other that of a bridge crossing into Anne Arundel County on the south. It joins the mainland with a maximum elevation, across the neck, of 35 feet above tide, and reaches an elevation of 90 feet in the interior. Having a shore more or less bold along its entire margin, it becomes very abrupt at "Federal Hill," at the upper end of the harbor. This district is known as South Baltimore and forms the southern limit of the city.

Lying upon the west side of the central stream, and extending about half a mile above the water front on the Basin, is an area of about 75 acres elevated not more than 10 feet above tide. This is called the "flooded district," from its having been on several occasions overflowed by the drainage from the back country during extraordinary storms; notably in 1868, when 20,000,000 cubic feet of water occupied the streets and residences of this densely populated section. From the margin of the "flooded district" the ground rises rapidly upon each side, reaching an elevation of 100 feet in a quarter of a mile on the west, and of 50 feet in the same distance on the east. Above this, along the whole course of the stream, the banks rise abruptly on each side.

On the north side of the harbor, lying between it and the Philadelphia Railroad, is an area of about 125 acres, the elevation of which is less than 6 feet above tide. It embraces the "City Dock," a pool 300 feet wide and 1,800 feet long, into which Jones's Falls has been conducted. It also receives Harford Run, the next largest stream which passes through the city. In dry weather both these streams, which have been converted by bad management into open sewers, are intensely charged with effete products of the population; and for which the dock acts as a catch-basin. This area embraces "District No. 1," already described in the first part of this report, and generally known as the typho-malarial district. As already stated, many of the residents in this district depend upon pumps in the neighborhood for their water supply, and cases of overcrowding in very old buildings have also been noted. The extent of the latter evil, heretofore commented upon, is thus described in the Sunday News of June 20, 1880:

"The people of what is called by some the malarial district are becoming more and more alarmed at the overcrowding of some of the old houses in southeast Baltimore by impoverished emigrants, the majority of whom are Bohemians. On Aliceanna street, between Wolf and Ann streets, is an old building (the square is known as Bohemian Row) which has a front of 30 and a depth of 100 feet, and is two stories in height. It was about half a century ago used as a private dwelling. It has now been cut up into twenty small compartments, into which, at present, no less than sixty-eight human beings—men, women, and children—are indiscriminately huddled. The sight of the barefooted women, the ragged men, the half-naked children attracts the attention of all passers. This week two children died in this hive, and others are sick. The stench from the place is sickening in the extreme, and the only fresh air the inmates enjoy is that which they get by crowding out in the side yard, as they are ashamed to appear on the street in their half-nakedness or ragged habiliments."

On the western boundary of the city, at the head of the other prong, is a cove of nearly 100 hundred acres in extent, into which Gwynn's Falls discharges. The sediment from this stream has nearly filled up the cove and converted the greater part of it into a marsh, leaving the remainder covered by a shallow stratum of stagnant water, bordered next to the city with a strip of low ground in a high state of cultivation. In this direction the ground immediately rises to an elevation of 16 feet along the line of the Baltimore and Ohio Railroad, and reaches 60 feet at Mount Clare, a half mile to the northwest, and gradually rises to an elevation of 230 feet in the extreme northwestern section of the city. On the opposite side the ground rises rapidly from the marsh; and below the cove the shore of the estuary continues with high ground and deep water throughout. Toward the north the course of Gwynn's Falls and its branches lies between steep hills. With the exception of the low areas just described, the ground rises everywhere with sufficient rapidity for the most perfect drainage.

GEOLOGICAL FORMATION.

With the exception of a ledge of gneiss rock which intrudes over a small area on each side of Jones's Falls, near the northern city limit, the whole of Baltimore stands upon a deposit of clay, sand, and gravel, sometimes alternating with each other, but with the coarser materials predominating at the base. Over a large extent, and on the highest elevations, a thick stratum of clean sand lies near the surface; while some of the lower outlying portions have at the surface a stratum of pure clay, the same which furnishes the famous Baltimore brick. At the base of all is a stratum of water-flowing gravel. This gravel is met with everywhere below the bed of Jones's Falls and at the bottom of the harbor along the water front. Beneath this is a thick and continuous stratum of tough, impervious clay, extending under the harbor, which the well-diggers designate as the "river bottom."

DRAINAGE.

In the western section of the city a stream called Schröder's Run originates at an elevation of 160 feet, in the neighborhood of the Cathedral Cemetery, and flowing southwest for two miles enters "Ridgley's Cove," just east of the marshy cove above described. Opposite to this, and draining from the same neighborhood, another stream, three-quarters of a mile long, discharges into Jones's Falls at the northern corporate line of the city.

At a half mile toward the east, and upon ground of the same elevation as the former, in the neighborhood of Eutaw Place, a stream called Chatsworth Run gathers the drainage and, flowing in the same direction for a mile and three-quarters, joins Schröder's Run just before reaching Ridgley's Cove. Draining from the same area in the opposite direction a stream a half mile long discharges into Jones's Falls nearly a half mile below the former one on this side.

Two other streams originate, at an elevation of 100 feet, in the neighborhood of the present Johns Hopkins University buildings; one, taking the course of Tyson, Liberty, and Howard streets, flows down upon the neck, where commences the peninsula of South Baltimore, and across which it has been conducted by a sewer along South Howard street and discharged into Ridgley's Cove, near the entrance of Schröder's Run. Its counterpart flows due east along Centre street, and discharges into Jones's Falls at the upper end of the "flooded district."

Another small stream gathers on Federal Hill, in South Baltimore, at an elevation of 75 feet, and flowing southwest for nearly a half mile discharges into Ridgley's Cove near the Howard-street sewer.

All these streams originate in and flow through fully-occupied sections of the city, and they are, in part, conducted through sewers of an irregular character. The two largest, Schröder's Run and Chatsworth Run, before reaching Ridgley's Cove flow in their ancient and natural beds for nearly a mile, and during warm, dry weather the water which they contain is usually black and reeking with noxious gases. The unoccupied portions of the western section of the city drain into a stream called Little Gwynn's Falls, which gathers in the neighborhood of Hookstown, a suburban village, two and a half miles northwest of the city limits, and enters Gwynn's Falls proper a mile above the cove. This is an exceedingly filthy stream.

In the eastern section (*i. e*, east of Jones's Falls) the first stream within the present corporate limits is "Jenkins's Run," which originates at the northern limits of the village of Waverly, more than a mile from the city, at an elevation of 200 feet, after draining, with several branches, a thickly-populated suburban district, in which are many slaughter-houses, distilleries, hair-factories, tanneries, and other foul establishments, it passes for a half mile through the city and discharges into Jones's Falls near the western portal of the tunnel of the Union Railroad, where that road joins with the Northern Central Railroad. Within the city it passes through a sewer 12 by 18 feet

diameter at the upper end, which sewer is reduced at the lower end, before it enters Jones's Falls, to a diameter of 7 by 7 feet.

The next drain is a small stream which gathers on Gallows Hill at an elevation of 120 feet, and flows through a sewer along McKim and Monument streets to Jones's Falls, where it discharges.

HARFORD RUN.

The third stream is Harford Run, which drains from "Clifton," the future site of the Johns Hopkins University, at an elevation of 200 feet, and a half mile beyond the city limits. After crossing the Union Railroad at Belair avenue it passes through a series of irregular sewers and drains, through yards, and under houses, to Central avenue, along which it is conducted by a regular sewer to the city dock. This irregular part of the sewerage of Harford Run nearly describes a circular arc, of which the Johns Hopkins Hospital, standing at an elevation of 110 feet and a quarter of a mile distant to the east, is the center. From the city limits to the dock the course of this stream is two and three-quarter miles. Its filthy condition has been a subject of public criticism for many years past, and the evil finally became so intolerable that the city council was induced last year to make an appropriation to improve the condition of the stream by changing its course and arching it throughout. The work is now in progress, but as it is not laid out in conformity with any plan for the future sewerage of the city, we may well believe that, except for temporary purposes, it will be a fruitless expenditure of money. In referring to this matter the Baltimore American of the 23d of July, 1880, thus forcibly speaks:

"Sooner or later Baltimore must have a thorough system of underground sewerage and drainage. The trouble, losses, and suffering that have been occasioned in the northeastern section by the overflowing of Harford Run by an ordinary summer rainfall emphasize the necessity of a comprehensive and systematic plan. Scores of families of poor people have had their homes undermined, their furniture injured, and the daily occupations upon which they depend for their bread and meat interrupted, because the municipal government has for twenty years been trifling with the nuisance of a slow-moving stream of filth, and has just resolved to endure it no longer. If the Harford Run sewer is not constructed with more engineering skill than was displayed in that on Liberty street, a great deal of money will again be expended without producing the proper results. The beginning of it proved on Tuesday a remarkably efficient aid in backing water into all the cellars in the neighborhood."

Another stream, called "Harris's Creek," drains from the neighborhood of the Baltimore Cemetery at an elevation of 175 feet, and flows south along the eastern outskirts of the city, where there have recently been erected blocks of new and clean residences. This stream enters the harbor immediately opposite Locust Point, the marine terminus of the Baltimore and Ohio Railroad, having had a course of two miles. The lower end of the stream, for nearly a half mile, formed a tidal inlet three or four hundred feet wide; but it has been nearly filled up with oyster-shells from the packing establishments and waste products of factories, furnaces, and residences. East of Harris's Creek at this point the ground rises immediately, and reaches an elevation of 125 feet at Highlandtown, a half mile distant. The lands of the Canton Company continue in this direction far beyond the city limits, preserving to the water's edge the most favorable conditions for drainage.

JONES'S FALLS.

In a sanitary point of view this stream may be said to be the *bête noire* of Baltimore, and has long engaged the anxious attention of the municipal government. Outside of the city, on the north, it receives the drainage of a large scattered population, and of the villages of Hamden, Woodbury, Waverly, and part of Govanstown, while the areas of greatest population in the city drain directly into the stream, and, as the city becomes extended, this will be increased in a still greater proportion. The evils arising from this state of affairs cannot be much longer endured, as public apathy on this important question of sanitation amounts really to a public crime. The following from the American of June 27, 1880, is not only a faithful picture but a just criticism of the nuisance:

"Jones's Falls cannot by any possibility be anything but a nuisance. Twice in the last half century it has overflowed its banks and inundated the sections of the city along its course, causing a vast deal of damage and knocking 50 per cent. off the value of contiguous property. The city has spent several hundreds of thousands of dollars to make such improvements that any freshet in the future will be confined within the retaining walls and the volume of water will not escape over them into the streets. But a flood is only a matter of occurrence only a few times in a century, while the nuisance of the falls as a malodorous cess-pool is with us every year. Just now it is at its worst. For several weeks past there has not been a strong enough wind from the north to drive out its stagnant waters, and the tides have simply acted to back them up between the basin and the Madison street bridge. As a consequence the

falls is rotten and nauseous with filth. The hot sun brings out from the still and polluted waters a terrible stench, just as it breeds maggots in carrion. The atmosphere in the neighborhood of the bridges is so poisoned with the malaria that a healthy man's stomach is turned by breathing it. From the surface of the water the mephitic gases may at any time be seen coming up in bubbles, and the stench seems to be the very essence of putrefaction. It must inevitably be a source of disease and death, especially as it pervades the atmosphere of the thickly-populated regions of Old Town and East Baltimore. A very heavy rainfall or a succession of northerly winds for several days would clean it out, but there is no certainty that nature will soon apply any purifying process, and meanwhile the falls goes on to help breeding a pestilence. If the water department has any water to spare, it cannot be put to better use than in flushing out the falls. The mass of stagnant filth ought to be removed; and if that is not done, the increase of the weekly death-roll will bear testimony that we have an uncontrollable nuisance in the heart of the city."

Were it not that the bed of this stream is required to give passage to the immense volumes of water which drains from a large extent of back country when a sudden storm breaks upon it, it could be converted into the main sewer of the city for its surface drainage. Lying as it does at the base of all drainage, and supplied as it is with a permanent stream of water, and capable of being flushed to any desired extent, it could also, economically and effectually, be made to serve as a final receptacle and conduit for a system of sanitation sewerage, for it could advantageously be continued to any distant point of discharge. Whatever system may be employed, the character and necessity of this conduit of distant discharge remains the same; it must lie at a low level, and be assisted by steam-power. Were this main sewer rendered practicable by the diversion of the floods from the back country, the loathsome sight of Jones's Falls, with its inconvenient and expensive bridges*, would be abolished, while a large and valuable space in the heart of the city would become available for building or other useful purposes.

That this measure is eminently practicable can hardly admit of a doubt. It is a subject which received the earnest consideration of the first engineer, Latrobe, grandfather to the present mayor of Baltimore. He recommended the diversion of the excess of water of Jones's Falls into Herring Run by means of a tunnel under Gallows Hill, upon a line which nearly coincides with the present tunnel of the Union Railroad, and thence by a canal to Herring Run. This plan could not now be carried out without interfering with the railroad system that has since been developed, and with a large and growing section of the city on the east. Moreover, it would be highly desirable that the advantage of such an improvement should extend as far as the probable future limits of the city.

Just where a northern limit line was established by the legislature of Maryland in 1874, and beyond the village of Woodbury, the bed of Jones's Falls lies in the same direction as that of Gwynn's Falls, where the Franklin road first comes alongside of it. The distance between these two points, about 3 miles, is nearly the shortest between the two streams; and the difference of elevation between their beds, about 50 feet, admits of an inclination of a water-way connecting these points sufficient to impart to the waters of Jones's Falls thus diverted a velocity of more than 10 miles per hour. The base of the intervening hill is an uninterrupted mass of gneiss rock, and its surface would be generally elevated 150 feet above the tunnel perforating it. It is estimated by Major Randolph that if such a tunnel had a width of 50 feet with a semi-elliptical roof 40 feet above the floor in the middle, it would pass a much larger quantity of water than that which passed the arch at Eager street bridge during the unprecedented flood of 1868. The stone derived from the excavation of the tunnel would be perfectly suitable for the construction of the proposed grand sewer of Jones's Falls, to replace the present open stream, which could be made of sufficient capacity to pass the volume of ordinary storms independent of diversion, and easily accessible at low water to carts or cars for the removal of deposits or obstructions, &c. The dam can be constructed across the narrow rocky valley in such a manner as to be beyond the possibility of breaking; and the tunnel would at least be as free from the contingency of choking as the arch at Eager street bridge.† Such a diversion would probably necessitate an increase in the span of several bridges across Gwynn's Falls; and a few strips of low ground which border it might possibly be more deeply flooded than usual when a rise in both streams occurred. But the necessary increase of damage along this deep valley, as improvements now stand or are likely ever to be made, would be but trifling. The cost of this diversion, without taking into consideration the value of the space reclaimed, has been estimated at $3,000,000.

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*Jones's Falls, from Boundary avenue to the city dock, a distance of not more than 3 miles, is spanned by not less than sixteen bridges, some of which have recently been erected at an enormous cost to the city. The city of London, with a population of 4,000,000, is traversed in its most densely populated sections by the river Thames for a distance of 12 or 15 miles, and it has only been found necessary in that great city to erect ten bridges and a single tunnel. The river Seine passes through the most populous part of Paris for a distance of 8 or 10 miles; it is only spanned by twelve or fourteen bridges.

†This diversion scheme was urged by me in a report made, as chairman of the joint standing committee on health, to the city council of 1873

WATER SUPPLY.

Five miles from the northern corporate limit the waters of Jones's Falls are collected for the use of the city, at an elevation of 225 feet, and are delivered through a conduit of 25,000,000 gallons capacity into the distributing reservoir in Druid Hill Park, at an elevation of 220 feet, from which it is pumped by steam-power into a higher one in the park, at an elevation of 325 feet. Beyond the dam the drainage territory which supplies the lake supports a large rural population, and embraces the summer residences of a large number of the more wealthy citizens of Baltimore City.

On a few occasions in the history of the present supply it has only amounted to one-third of the capacity of the conduit. As a supplement to this, on such emergencies, steam pumping engines have been located upon the Gunpowder River, about 6 miles distant from the dam. They force the water through a pair of pipes to the top of the intervening ridge, from whence it flows into the lake, thus increasing the supply with 10,000,000 gallons daily.

In another year the works for the new supply will be completed. This will draw the water from the Gunpowder River 4 miles below the present pumping engines, to which point the dam will back up the water, and conduct it through a tunnel 7 miles long, and of a capacity of 160,000,000 gallons daily, with reservoirs on Montebello and Clifton, having an elevation of 165 feet. This quantity is the volume of the river at its ordinary low stages, and can be supplied by gravity to all those districts lying below an elevation of 100 feet above tide. Naturally this water is of uncommon purity and softness, and at present comparatively free from contamination. It is stated that on one occasion a measurement showed that the river only supplied about one-third of the capacity of the conduit. This proportion of one-third supply at periods of extreme drought in both the new and old supply coincides with the case of the Croton supply for the city of New York. As in the case of the Croton River, the valley of the Gunpowder offers numerous and highly favorable situations for an indefinite and superabundant amount of storage, a system which is very conducive to the purity of the water. Thus it appears that for the present and for the future Baltimore has extraordinary advantages in her water supply.

THE BASIN.

The emanations from a thousand alleys and gutters and from sixty or seventy thousand privy-vaults, the leaky pipes of three gas companies, the manufacturing of soap and agricultural fertilizers, and the slaughtering of thousands of animals, with a great variety of other malodorous operations carried on within the city, supplies the atmosphere of Baltimore with a number of smells equal to that of the city of Cologne. But the odor which emanates from the basin, the city dock, and the tidal range of Jones's Falls during the dry spells of summer is one of the monuments of the "Monumental City." In Schröder's Run and Harford Run this offensive condition is generally present during warm weather in one or two days after a rain. In Jones's Falls it begins in about a week after a copious flushing. In the large body of water constituting the basin the time is modified by the direction of the wind and the concurrence of extraordinary tides. When the wind prevails from the southeast the discharge from the city dock is wafted into the basin. When it blows from the northwest this foul fluid is scattered and commingled through the wide expanse of the lower harbor, and the surface-water of the basin itself is driven out and scattered before the sun has fully induced the chemical action. But at all places in Baltimore and in all cities the effects of polluted water subject to the heat of summer is the same; it becomes black and bubbling, evolves sulphureted hydrogen and other noxious gases, and gives a dark hue to white paint.

It frequently happens that immense numbers of fish enter the basin when the water is in a state of comparative purity and remain there until Jones's Falls, the great generator of the foul and poisonous water, accumulates it in their rear, cutting off their retreat, and then the water in the entire basin gradually assumes the same condition, until it will no longer support animal life. On such occasions the fish are seen floating in thousands on the surface and loading the atmosphere with another noisome odor. It is well known that the pollution of the basin has been at times greatly increased by a violation of the law forbidding the emptying of night-soil into its waters by those engaged in cleaning privy-vaults. In the past few years this practice has been somewhat checked.

Dredging machines are now constantly employed in removing the black mud and slime which is always accumulating in the docks and along the pool of Jones's Falls. These foul sediments have been deposited at various points near the shore several miles below, where they have created similar nuisances in the neighborhood, and for which fines have been imposed upon the contractors by the legal authorities of Baltimore County. In one instance damages were awarded to the extent of $10,000.

In 1859 a commission appointed by the mayor and city council and headed by Henry Tyson, civil engineer, reported a plan for a system of sewers to be located along the

principal depressions and designed to carry the surface drainage to the nearest tide-water, in which occurs the following paragraph relating to the pollution of the basin: "In most European and American cities, the water-closets are allowed to discharge into the sewers. This plan, we think, may be advisable in cities located on the sea-coast, the harbors of which are swept by the tide, or upon the banks of large rivers with strong currents. To pursue this system with the city of Baltimore would turn its landlocked harbor (the basin) into a vast cess-pool and materially affect the health of the city during the summer months. The Thames at London has become so polluted with the increased size of the city that the English Government has now under consideration the propriety of conveying off the drainage to the sea, near the mouth of that river, by immense conduits. The plan for the accomplishment of this object by Messrs. Bazalgette & Haywood, it is estimated, will cost £3,000,000."* This report seems not to have recognized the fact that the basin was already a "cess-pool," and it ignored the fact that many thousand self-draining wells were then discharging into it.

In 1871, Engineers Craighill and Kneass, employed by another commission, reported a plan for the improvement of Jones's Falls, principally with a view of preventing overflow. In referring to the basin they make the following suggestions: "A good method of correcting to a great extent the filthiness of the basin is, to arrange near the outlet of each sewer a receptacle where the most corrupting elements may be caught, purified, and removed. Private sewers, emptying into the basin, should be strictly prohibited. The great sewers, after receiving the contents of the smaller, should be few in number when they reach the basin. It will be neither difficult nor expensive to prepare for each of these large sewers, in the dock in which its mouth shall be located, such a receptacle as has been referred to above, where the more solid matters may be collected and removed at suitable intervals." This report also ignores the existence of the subterranean flow from the bottom of the deep wells, and assumes that everything not solid or no heavier than the water in which it is finely suspended, may be allowed to escape into the basin with no evil consequence.

In 1873 Mr. Wm. J. McAlpine, civil engineer, employed by a commission appointed to devise means for purifying the basin, submitted a report in which the following occurs: "The substances causing these noxious exhalations are brought into the basin—first, by the present sewers; second, by superficial street drains; third, by garbage thrown into the basin; fourth, by the flood tides which carry the foregoing matters forward and deposit them in the basin." Mr. McAlpine, like the other engineers, has also ignored the effect of the self-draining wells in polluting the waters of the basin.

In February, 1876, Mayor Latrobe sent to the city council a special message in relation to the basin nuisance, in which he says:

"Summer after summer our city is assailed during the heated term with a most abominable stench, arising from what is now the receptacle of the filth of a great and rapidly growing city, emptied into it by our present system of surface and sewer drainage. With each succeeding year during this noxious period, the people cry aloud against a continuance of an evil that actually threatens the necessity of an abandonment of the immediate neighborhood of this 'pool,' or the lives of the whole community by aiding any migratory pestilence that might visit the city. This nuisance should certainly be abated, and whatever reasonable cost might be incurred would, if honestly and economically expended, be cheerfully met by the people.

"Either the smell of the basin must be cured, or the city of Baltimore will be driven from its shores. There is no other community that would in the present age of refinement and high civilization so long endure such a curable evil."

Mayor Latrobe, under date of September 11, 1876, in another message to the city council, takes occasion to remind that body again of the basin nuisance, and suggests the remedy of an intercepting sewer. His language is as follows:

"For many years past the city of Baltimore has used the basin as the common receptacle of all its sewage, notwithstanding the fact that summer after summer we were reminded by its disagreeable odor that this nuisance should be abated.

* * * * * * *

"It is certainly manifest that, independently altogether of the sugar refineries, if the city continues to annually discharge its constantly increasing drainage of filth and sewage into the almost tideless waters of the basin withoutco nstantly dredging it out again, the water must necessarily become polluted, and exhale noxious and offensive odors, constantly threatening the health of our citizens.

"Under these circumstances it becomes a matter for consideration whether the certain cure of any recurrence of that well-remembered 'stench,' without interference with our manufacturing or commercial interests, would not be the construction of the intercepting sewer recommended by the committee appointed by the city council in 1873, and provided for by the enabling act of the last session of the general assembly. If this is the remedy—and I believe that it is—it becomes a question for your honorable body to consider whether this is not a most favorable time for the commencement and prosecution of the work."

* This plan has since been carried into execution, and the actual cost was $5,000,000.

Again, in his annual message to the city council, January 1, 1879, Mayor Latrobe uses the following language in reference to the basin:

"During the winter months we are so free from the basin nuisance that, forgetting its offensive summer odors, we are led to believe that perhaps the basin at last has cured itself. The permanent abatement of the basin nuisance is, however, a subject to which the attention of the council should be earnestly directed. Many plans have been suggested, and public opinion seems to be divided upon the subject. For my own part, I have always believed in the necessity of preventing the basin from being made the receptacle of the filthy sewerage of the city, by the construction of an intercepting sewer, as is being done in Boston, with which the sewers already constructed, and those required hereafter, could be connected. Such a sewer would receive and carry off to some point on the river, where it would be swept away with the tide, all deleterious matter discharged from soap factories, sugar refineries, gutter drainage, &c., that now finds its way into the basin. There are others, however, who think the nuisance would be better abated by the adoption of a plan for flushing the basin with pure water, and thus cleansing it by dilution. The subject is one of importance, and the public will never be satisfied until the different plans have been submitted to scientific investigation. For this reason I suggest that power be given to the mayor to appoint a proper commission of three gentlemen with the requisite knowledge on such subjects, who shall make an investigation into the cause of the basin nuisance and suggest a plan for its cure. The expense attending such an investigation would be small, and the report would doubtless enable the city council to estimate the cost of what at no very distant day must be undertaken by the city."

We thus see that there is an accumulation of authority for saying that the basin, under existing circumstances, is a foul, disease-engendering cess-pool, and that the abatement of the nuisance is essential from every point of view. The whole question is manifestly one of difficulty, but it is one which deeply concerns all classes of the community. No class possesses an immunity from the evils which the neglect of the laws of sanitation bring into existence; all are subject to their influence. Hence the importance of the municipal authorities taking boldly hold of this question. The safety of the people should be the supreme law!

The plan of an intercepting sewer along the water front to connect with the present sewers, as well as those which may be constructed in the future, and conduct their flow to some point below the harbor, is undoubtedly the first and most important step towards abating this great nuisance, provided it is so constructed as to intercept the unperceived flow which now issues from the many thousand self-draining privies, through the gravelly base of the city, at every point along Jones's Falls, as well as the whole water front.

Many intelligent citizens of Baltimore have, apparently, satisfied themselves that the odors, or, as Mayor Latrobe aptly terms it, "the stench" of Jones's Falls and the basin are almost entirely due to the operation of refining sugar, with the discharge of the waste products into these receptacles. But it is an unquestionable fact that the existence of the stench preceded the establishment of the refineries, and has continued to a large extent since the abatement of the alleged nuisance. Thus, in February, 1855, Capt. Montgomery C. Meigs, United States Engineers, now Quartermaster-General of the United States Army, who was consulted, thus expressed his views in reference to an additional water-supply: "Every reason which would induce me to recommend a liberal supply of water for Washington applies with equal force to Baltimore, which, moreover, needs a larger quantity of water to purify the stagnant harbor, *whose odors during the last summer must be in the recollection of all its inhabitants, as they are with that of all who passed through the city by railroad.*" At this period the Calvert refinery, which is charged with all the evil, was not built, and the business of refining sugar in Baltimore was just commenced on a very small scale below the basin, where the operations have never been considered in this question.

So, too, although the refining operations have ceased since 1878, the old complaint has repeatedly appeared along the pool of Jones's Falls and in the basin during the past two summers, showing conclusively that the disagreeable odor is largely, if not entirely, independent of the sugar refineries, and can therefore be ascribed to no other cause than that of the putrescent matters which constantly flow into Jones's Falls and the basin from almost every section of the city.

"It is evident," says Mr. McAlpine, "that if the water in the basin was pure, and no offensive matter was allowed to come into it, and the semi-daily tidal inflow was pure sea-water, its waters would emit no unwholesome exhalations. The first step, therefore, is evidently to prevent the entrance of all sewage and matter from superficial street drains, and also, as far as possible, the defilement from the inflowing tide.

"Upon any plan of reparation of the basin, the diversion of the sewage and street washings must be first made, and then must be the prevention of the contamination of the inflowing sea-water from the same defilements. Hence follows the necessity of sewers of sufficient capacity to carry off all such matter, and discharge it far enough below the basin to prevent it being subsequently brought into it by the tidal flow."

PART III.

THE QUESTION OF SEWERAGE.

This subject has already been several times adverted to, but its importance demands still further notice. Although, for general health and exemption from epidemic diseases, Baltimore has hitherto occupied a very high rank among the cities of the world, there has never been inaugurated any general system of sanitary works, nor has there ever been authorized a thorough scientific study of its sanitary conditions, having in view the elimination of all obnoxious elements through the means afforded by modern science and skill. Under the temporary excitement occasioned by a destructive flood in the stream which traverses the oldest and densest section; by the overflowing of the insufficient water-ways provided for several drainage areas in other parts of the city; or by the prevalence of a foul atmosphere of extraordinary intensity and duration arising from the harbor and the streams flowing into it, spasmodic attempts have been made at the time to institute measures adequate for the suppression of the evils then apparent. But the subject has always been dropped with no other result than the display of a "multitude of counsel" and a great conflict of opinion. Several extensive schemes, involving large expenditures of money, have been on the point of realization, but have fortunately failed, as they were proposed without a thorough understanding of the whole subject with which the questions were necessarily connected, and seemed to be supported principally by the pecuniary interests involved in their execution.

The few existing sewers have been constructed entirely with a view of conducting the surface-drainage which accumulates along the principal depressions. In certain sections along Schroder's Run, Chatsworth Run, and Harford Run, they present the greatest variety of form and capacity, and follow crooked and oblique courses across the squares and under the houses, alternating with open drains, walled up with loose stones and sometimes covered with planks. They have been adapted to the exigencies, as they arose, of certain limited localities and periods, regardless of any general plan, or the requirements of other times or places. Although it is contrary to law to devolve upon the sewers the function of scavenger, yet its violation is seldom inquired into, or reprehended when coming to the notice of the authorities; while in many cases permits are granted for private drains of this character to connect with them. Still more frequently, both by accident and by design, the overflow from vaults and imperfect sinks reach them by way of yards, alleys, and street gutters. In many places, as has been stated, these receptacles were found "running over," an occurrence which is more frequent in hot weather, in consequence of the generation of the gases of decomposition. The water-way provided by these conduits is, in a number of instances, entirely insufficient for the passage of the volumes of water which reach them after a heavy fall of rain; and they have been repeatedly overflowed, scattering their foul admixtures over yards and into cellars and basement rooms. At all times during the summer they exhale an odor which is a public nuisance. In the western section of the city some of these insufficient conduits have been supplemented by regular sewers following the line of streets to relieve them from floods, but without abolishing the old systems, which continue to perform their illegitimate office of house and vault drains. Several sewers have been constructed for the express purpose of draining certain public establishments. One of these sewers receives the sewage of the new city hall, and from two of the principal hotels, which is discharged into the docks along Pratt street.

But the almost universal practice of getting rid of excretal sewage is by the simple well, varying in depth from 3 to 75 feet, and walled up with dry brick-work. This system dates from the foundation of the city, and has been extended with the growth of the city. In the commercial section of the city, contiguous to the basin, these wells, although not exceeding 10 or 15 feet in depth, in many places have a free communication with the tide, which rises and falls within them through the intervening stratum of gravel. Thus their contents are constantly disintegrated and dissolved and discharged, finally, into the basin, a process which has been going on, in many cases, for half a century. In a district embraced by Charles, Baltimore, Pratt, and Harrison streets, 65 per cent. of these wells do not require artificial emptying; in another section embraced by Read, Calvert, Biddle, and Cathedral streets, for the most part elevated 100 feet above tide, 34 per cent. of the wells are self-draining, it being necessary for this result to carry them down to a depth of 40 or 50 feet. Another district embraced by Fremont, Franklin, Gilmer, and Lanvale streets, with an elevation of 150 feet, where deep wells are more general, 62 per cent. are self-draining. But in another district, mostly occupied by old and indifferent dwellings, included between Boundary, Fayette, Chew, Gay, and Asquith streets, and traversed by Harford Run, not more than 5 per cent. of the wells are self-draining, and these

are confined to certain blocks of new houses. The remainder of the wells in this district do not average a depth of more than 6 feet, and consequently require to be emptied three, four, or five times annually. It is safe to assume that one-third of the houses of Baltimore are now provided with deep or self-draining wells, but most of the water which is constantly discharged into them finds a slow exit and reaches the subterranean conduit afforded by the beds of gravel, and carry in solution the materials for future noxious exhalations. Many of these wells are confined to an impervious soil, and frequently, as has been seen, discharge over the surface into the street, or, what may be worse, they penetrate a sandy soil only to where a stratum of clay intervenes to arrest a downward flow; and here the noxious fluids permeate the sand in all directions near the surface and frequently issue into the foundations of houses. An instance of this sort can be cited in one of the most elegant neighborhoods in the city, having an elevation of 100 feet, with the surface sloping in all directions. Here the well is of insufficient depth and is located in the yard, which is 7 feet higher than the kitchen floor. Every few months the cook is disagreeably notified, by the water invading the kitchen, that the well needs attention. This, although a very prominent case, is doubtless an exceptional one in that immediate neighborhood. There are, however, sections of the city in which this condition of things is the rule, and no section is free from defective wells.

Referring to the cases of a porous soil permeated with such matters to the extent acquired by slow exudation and capillary attraction, we have very high authority for considering such conditions eminently insanitary. In his report on the sanitary condition of the city of London for the years 1866–'67, Dr. Letheby, health officer, in discussing the cholera epidemic of 1866, says: "The theory of Pettenkofer is that the essential conditions for the active manifestations of the disease are a porous soil charged with excrementitious matter and having a certain degree of hydration, as happens when the subsoil water is just drawn off or slowly retiring. All these conditions are singularly coincident with the localization of the disease in the eastern districts of London; for the soil is gravelly and therefore very porous to air and water, and is largely charged with excrementitious matters derived from the local tide-locked sewers. It is also remarkable that for some months before the outbreak of the disease the subsoil water had been gradually sinking in consequence of the drainage operations that were necessary for the construction of the main lower-level sewer and its branch to the Isle of Dogs. Now, according to Pettenkofer, it is exactly under these circumstances that a district is most liable to choleratic infection."

Here is the theory of the most celebrated sanitarian in Europe confirmed by the observations of the health officer of London; a theory which finds a direct application to a large portion of Baltimore, where "a porous soil charged with excrementitious matter having *a certain degree of hydration*" prevails in consequence of the slow percolation and absorption from the wells.

In every part of the city, high and low, among the rich as well as with the poor, there is an escape of noxious gases from these privy-wells, which becomes very much more disagreeable and apparent during the heat of summer; and the fluids escaping from kitchens and sculleries, not less harmful if less offensive, maintain perennial streams in all the gutters, and either directly or indirectly find their way into the harbor, which is the common receptacle for all the filth of the city as well as drainage of a large back country.

With regard to the self-draining wells, there are many who contend that the simple passage through strata of sand and gravel deprives the water of the deleterious matter which is held in fine suspension or in solution, and that this fluid finally issues into the harbor in a state of purity.

That these fluids are not filtered of their impurities is conclusively proved by the fact that the water of the springs and pumps in the city, upon which many of the people have depended for their supply, when subjected to a few days of summer temperature, exhale the same fœtid gases which arise from the docks. The chemical analyses of Professors Remsen, Tonry, and others also proves that the water in many of these drinking-wells is so charged with deleterious elements that the use of water from them, as well as from the springs in the city, for drinking purposes has been forbidden by the health department. But these waters are far from being indicators of the composition of the fluids pervading and constantly flowing from the substratum of the city into the harbor. They have their pure sources in the elevated regions at a distance; they follow fissures in the rocks, and strata more or less isolated from the general formation under the city, and enter it with a pure volume, and subsequently commingle with the polluting product of the city in the wells. They are, therefore, although contaminated, pure compared to that which flows from the privy-wells into the subjacent soil, and finally into the harbor.

If a total suppression of the privy-well system should be determined upon in favor of a general system of sewerage, which the city so much needs, a question would arise as to the most efficacious and economical method of carrying out this measure. If the sewers are constructed with a view not only of performing a sanitary office but at the

same time to receive and conduct the volumes of water which fall upon the surface during storms, it will necessitate adequate dimensions, and which are vastly in excess of what the first duty would require. These excessive dimensions would be imposed upon tubes which must be maintained in accurate form and position, of smooth and regular interior, water-tight throughout, and secure from all liability to fracture, obstruction, and escapement, increasing to a corresponding extent the cost of securing these features. They must also be provided with special cleaning, trapping, and ventilating arrangements on the same scale—features, in part, unnecessary for the second duty alone.

The *débris* with which the public streets are always strewn—sticks, stones, bricks, and every variety of trash—will be constantly swept into these sewers by a sudden torrent of rain, causing obstructions troublesome to remove and frequently choking them to the extent of forcing their promiscuous contents into the streets and cellars. They arrest within their numerous traps deposits of the foulest nature, requiring the most awkward and offensive operations for their removal. The traps for intercepting gases are more apparent than real. The small body of water interposed absorbs the gases on one side and exhales them on the other, a process which increases with the pressure within the sewers; while most frequently the obstruction interposed by the trap only determines the escape of the gases into sleeping apartments instead of the open air of the streets.

A sufficient and uniform supply of water is absolutely essential to the proper operation of a sanitary sewerage; but the sewers, which are designed to be assisted in their action by the surface drainage of the streets, find such assistance to fail them totally at the very period when it is most needed, that of heat and drought, or else they are disrupted or choked, and their contents diverted by a deluge of rain succeeding the drought. Most frequently the assistance of the rain is either absent, unnecessary, or in injurious excess.

To provide for the passage of storm-water requires not only the extra expense of the large scale upon which such nice and particular work as required for sanitary sewerage must be executed, but it requires conditions, due to the size of the vent, least favorable to the flow of the limited and uniform volume which alone can be relied upon. Instead of having a channel with the least surface in contact with the fluid, which is the measure of the resistance to the flow, this becomes the flat arc of a large circle, presenting a much greater surface of contact to the same volume. Where the inclination of these sewers is slight, a greater depth of water is acquired by accumulation, with consequent stagnation and putrefaction; where the inclination is rapid, floating solids become stranded along the sides and bottom with still worse effect.

A consideration which has influenced the adoption of the combination system is the advantage of having the beds of the streets to coincide with each other where they intersect, and thus avoid the interruption caused by the gutters of one street extending across the middle of the other, which occasions either an annoying check in the speed, a disagreeable jolt, or a complete stalling. This is obviated when the streets are provided with sewers. The gutters then terminate at an inlet instead of crossing the other street, which enables the middle of both to coincide in a common plane.

This system requires such an extent of sewers for surface drainage that it is combined with the other as a measure of economy and justification. The evil effect of it is illustrated in the sewerage of several American cities, notably the city of Washington, whose streets have been graded and paved with special reference to the driving of elegant equipages and vehicles of pleasure. Here every inlet informs the passer-by of the existence of a stagnant cess-pool beneath the street, or of the incomplete transportation of matters assigned to an insufficient volume.

In the city of Baltimore this gutter interruption is, in many places, remedied by bridging them over with plates of cast-iron, corrugated upon the upper surface, which yields a most disagreeable noise to every passing wheel. At every heavy rain they become choked with the trash and garbage washed down from streets and alleys, creating an overflow above them and leaving a deposit of putrescible matters beneath them.

In many of those streets coinciding with the natural depressions on the surface of the ground the water accumulates during heavy rains to such an extent as to become a formidable obstruction to pedestrains, and frequently invades the sidewalks and cellars. During severe freezing weather, with the ordinary drainage, large accumulations of ice occur, which have to be removed from time to time to enable vehicles to pass. At some of these places stepping-stones have been provided, at others a complete remedy has been effected by sewers below the surface to carry off the storm-water. In these instances a sewer for the surface drainage, leading to the nearest available outlet, no city should forego; but much the largest proportion of the streets have only to drain the territory in their immediate vicinity, and but for the constant small stream of impure water discharged from the houses would need no gutters, for there could be no objection to the storm-water flowing in a uniform sheet over the entire breadth of the street over the curb-stones of the sidewalk, as its duration would be

short, and concur with the absence of pedestrains from the streets. If the streets were so graded as to form a regular plane, instead of a convex surface, and thus constitute one broad gutter with a flat bottom, and bounded with the curb of the sidewalk on either side, there would be no interruption at their crossings, and the surface drainage would be perfect.

So long as it is permitted to discharge impure waters upon the streets, it will be a necessity to concentrate them into gutters; but if the law compelled all such fluids to flow into sewers, with which every house necessarily formed a junction, and allowed only the pure water of the private hose, the street-sprinkler, and the storm and showers to flow upon the streets, the gutters over the largest area might be dispensed with and one crying nuisance abolished.

In every well-governed city the dirt which must necessarily accumulate in the streets is regularly swept up and carried off; and where the streets are properly graded and paved this operation is an inexpensive one and can be rapidly and economically performed by machines. In some cities the value of the product is more than the expense of removing it. In Baltimore, where the streets are in the most primitive condition, this process is an expensive and tedious one, and consequently is resorted to at long intervals, during which the dirt becomes the sport of the winds, and, in the summer time particularly, is distributed through the dwellings. But whether this sweeping is sufficient or not, there can be no very great evil in allowing the washings of the streets during falls of rain to flow directly into the harbor. Its character and quantity is such that it does not readily undergo offensive decomposition, and its removal thus is always accompanied with that great preventive, a copious supply of fresh water; but this cannot be said of those innumerable and perpetual streams of composite fluid which now flow in all the gutters, either lawfully or they are too widely distributed and too difficult to trace to be prevented by the police. That which finally reaches the harbor must contribute its full share to its pollution, unless it has exhausted its effect upon the atmosphere of the city during its slow journey. The greater part is absorbed by the sandy soil upon which the gutters and pavements are laid, passing through the spaces between the bowlders and spreading through the heated soil near the surface. The proper disposition of all such fluids is unquestionably the sewer of sanitation.

If the well-system is abolished—which a proper regard for the future health of the community demands—and the surface drainage continued, with sewers only in the principal depressions, and they restricted only to storm-water, then a system of special sewerage, devoted exclusively to sanitation, must be adopted. In this we have to deal with a subject whose conditions are constant and uniform, and within the range of easy calculation. This highly important operation will admit of the application of the most scientific and skillful devices in the smallest proportions necessary for one office, and enable the sanitary engineer to accomplish his object with certainty and economy. And if any apparatus or process should hereafter be invented by which the barren and impoverished soils which cover so large a territory in the neighborhood of the city may be profitably restored to a healthful and attractive fertility as the result of such operations, the special system of sewerage will be the best calculated for their application. The sewer for receiving the storm-water, though important, should be postponed to that which is a necessity. It has become imperative to lessen the nuisance occasioned by the present system of privy-vaults, as well as that occasioned by the drainage from kitchens and sculleries and overflowing slop-tubs and garbage-receptacles, and that resulting from the pursuit of many industries, all of which now join in the general chorus of the gutter rill. The following from the Baltimore Sun of August 5, 1880, is pertinent to the subject:

"SEWERS, SEWAGE, AND SEWAGE FARMS.—Before long the city council of Baltimore may be called upon to consider the question of sewerage. Dr. Billings, an excellent authority, has expressed his opinion that a system of sewers is essential to the health of the city. So also declare the State board of health and our local board of health commissioners. What is meant by 'a system of sewers' we have yet to learn. An intercepting sewer, constructed on the plan of the Hambleton survey, to catch and carry off the drainage that now finds its way to the inner harbor, only to be dredged out again at a large annual expense, is undoubtedly desirable, provided sufficient fall can be given to it to take the sewage far enough down the river, either to be utilized on what are called 'sewage farms,' or, if discharged into the river itself, to prevent its return by the inflowing tide. The plan of sewerage recently adopted in Memphis and other cities may possibly be found suitable to Baltimore. It consists in the use of pipes to carry off the house sewage only, leaving storm-water to be carried away by surface drainage. Such a plan, with the surface drainage and also the smaller net-work of sewers discharging into the main intercepting sewers, might be carried out at a not unreasonable cost, considering the sanitary benefit to be derived from it, and the trouble and expense and continual harassment to which the city is subjected in finding unobjectionable dumping grounds. Philadelphia is at this time experiencing a similar trouble, not only from the poisoning of the soil by the liquids from privy-wells, of which it is

estimated that nearly 500,000 persons make use, but also from the fact that 'the sewage of 290,000 persons daily reaches the rivers, which, after a long drought, are likely to be polluted.' But underlying these facts is the important question as to what shall be done with all this sewage. Experience thus far favors its use by distributing it among sewage farms. In Massachusetts this distribution of the sewage on a small scale has been attended with marked success. There the experiment has been tried at the Danvers and Worcester Asylums. At the latter the sewage farm is distant half a mile from the building, and the sewage is carried to it through simple trenches and distributed at the rate of 3,000 gallons per acre. At the Danvers Asylum the sewage is carried about the land near to the house by means of simple wooden troughs, and it is said that 'with a little intelligent care all offensive odors are avoided.' In both instances much larger crops are raised than ever before. At Lenox the subirrigation plan of the famous English agriculturist, Mr. Mechi, has been adopted, the sewage being distributed through a series of ordinary tile drains about a foot below the surface of the ground. In England this mode of distributing sewage has been extensively used, and the plan has been fostered by the annual prizes which the Royal Agricultural Society offers for the best sewage farms, including similar farms in Ireland and Scotland. There are about one hundred of these sewage farms in operation in Great Britain. According to the report recently published, and as might have been expected, it has been found that the great market gardens within easy distance of large cities return the most profit from the use of sewage. One other important conclusion is reached by the committee. It is in respect to the sanitary effects of sewage on the hands employed on sewage farms. It was found that 'among the persons either living or working on the farms the average rate of mortality did not exceed three per thousand per annum,' which is 'not more,' it is said, 'than an equal number of selected lives taken from an agricultural district.' What the effect of sewage on the health of field hands would be in our hotter climate is yet to be determined."

The sanitary condition of Baltimore is a subject worthy the consideration of both the municipal, State, and national health authorities. That the existing evils are dangerous *per se* there is no evidence to affirm; but how far they may be capable of developing any of the diseases which need some germ or some special chemical or physical cause for their initiation is a subject upon which science throws a feeble but sinister light. The combined labors of those who pursue chemistry, biology, medicine, and physics are required to guide the sanitary engineer in any measures except those which are dictated by the instinct of man and even animals, to seek pure air and water, to hide, avoid, and banish every element rejected in the organic process of life, or capable of contaminating the atmosphere.

The ever-growing necessities of an increasing population should be met by a corresponding activity of the mind and will. But a large portion of the inhabitants of our large cities find themselves powerless to obey those instincts which nature seems to have provided to indicate the true sources of health. They find themselves imprisoned in close quarters with thousands of their fellows, in an atmosphere saturated with foul vapors, without the means of securing sufficient or appropriate food or even pure water, and without protection from the extremes of heat, cold, and dampness. It is for the more fortunate, intelligent, and thoughtful members of the community, who witness these arsenals of disease gathering the elements of avenging epidemics, to aid with their influence in inaugurating a thorough and systematic plan of sanitation, and to take the first steps in a series which shall finally complete it.

Epidemics need only those unknown but sufficient causes to kindle a flame which may include in its devastations the most salubrious as well as the most filthy district; and the sordid man who locks up his pocket and votes against a tax to prevent or correct such evils cannot guard his own spacious and luxurious abode against the malady his own avarice has helped to originate. "*Pallida mors æquo pulsat pede pauperum tabernas regumque turres.*

Respectfully submitted,

C. W. CHANCELLOR, *M. D.*

APPENDIX O.

REPORT OF COMMITTEE ON THE NOMENCLATURE OF DISEASES AND ON VITAL STATISTICS.

WASHINGTON, D. C., *October* 20, 1880.

SIR: The committee upon the nomenclature of disease, &c., appointed at the conference called by the National Board of Health, in Washington, May 6, 1880, respectfully submit the following report and recommendations:

As regards the nomenclature, we have, in accordance with our instructions, carefully considered the matter, and have communicated the results of our deliberations to the committee of the Royal College of Physicians, which is now engaged in the revision of this nomenclature.

We append herewith (marked A) a copy of the communication which we have addressed to this committee, and the matter will probably be presented in more detail by a member of our committee, Dr. Folsom, who will visit England within a short time.

As several States and a number of cities in this country are just beginning to publish reports of their mortality statistics, we deem it expedient to present at once a preliminary report as to the best methods of tabulating such statistics, and upon this we would remark as follows:

I. The question as to the best forms of tables for the *publication* of such statistics is quite different from the question as to the best forms to use in their *compilation*. Very much compilation work must often be done to obtain results which can be published more briefly and economically in a very different form, or which may not seem worth publication at all after they have been obtained.

II. The three great objects to be obtained by the publication of mortality statistics are, 1, as a warning of the existence of an excessive amount of disease, especially of the preventable forms, with reference to immediate action; 2, to educate the people as to the importance and interest of such matters, by getting them to compare their own situation as to healthfulness with that of other communities, and to see themselves as they are; 3, as material for the studies of the scientific statistician and the seeker into the causes of diseases.

The first object can be best attained by weekly reports for towns and cities, which reports should be brief summaries of the data of the previous week. A postal-card form for such a weekly statement is appended, which is essentially the same as that used by the National Board of Health. (Appendix B.) It is advised, to secure uniformity in time, that the week be held to end on Saturday at noon, and to include all deaths reported up to that time, without reference to the date of death.

This postal report should be sent to the National Board of Health for publication, and the information contained in it should also be given to the local press, with such additions and comments as the health officer can conveniently furnish. Under some circumstances, as during the prevalence of an epidemic, such reports would be required daily.

The second object above referred to is to be promoted by the publication, side by side, of many such weekly reports as have just been mentioned, and by similar comparisons in annual reports. It is unnecessary to refer to the forms needed for this purpose, as they will be discussed under the next head.

The third object is the one that presents the real difficulties. We will first take the case of a city, or single registration district, where the mortality tables are to be compiled directly from the original records.

III. The data to be compiled are (or ought to be) date of death, age, sex, color, birth-place of parents, nativity, occupation, social relation, locality of death (street, ward, &c.), and cause of death.

The items "color" and "birth-place of parents" are relied on to show the race or nationality of the decedent. The item "nativity" refers to the birth-place of the decedent, and is useful rather for genealogical and judicial purposes than for vital statistics. (With regard to the item "race," it is not to be taken as equivalent to "birth-place" or "nativity." The birth-place of the parents, which should be shown on the certificate, will be usually taken to give the "race.") The results of the com-

pilation of these data are to be compared to the living population, the birth-rate, the occupied area, the meteorological and other special conditions of the environment, and with the results obtained in the same locality in previous years.

For statistical purposes, the month should be made the unit of time, although the tabulations we are now discussing will be published but once a year. For educational purposes, and as a matter of local interest, it will be well to publish monthly summaries, which, however, would differ little in form from the weekly reports already referred to.

IV. The first table which a city should give in its annual mortality report, and which should be compiled in the same form, should be one showing the number of deaths from each cause by age or sex.

In all cities where the number of persons of different races or nationalties is large enough to make it worth while this table should show also for each sex and age the races, as American whites, American blacks, English and Scotch, French, German, &c. We think this should be done for any race or nationality which forms 5 per cent. or more of the total population.

A form for such table is appended, marked Table I. So long as each cause of death appears separately the precise nosological arrangement or order of sequence is a matter of minor importance, but we advise following the order of the nomenclature of the Royal College of Physicians that the order may be the same in all the tables. The information contained in this table is essential to the vital statistician. It cannot be abbreviated without losing much of its value; it will not do to give deaths by ages separate from those by sex. The division of ages, indicated in this table, is the least which will permit of making comparison with the statistical reports of other countries. It is desirable, however, that the deaths under one year be still further subdivided, and that special studies be made of the deaths by days in the first month and by months in the first year. The importance of distinguishing the race or nationality is very great in the United States at the present time. No other country presents such an opportunity for the study of the effects of race or nationality in disease and mortality; nor will it be possible in this country to study it many years, and hence the great importance of making use of the fleeting opportunity.

In those places where the birth-place of parents is not reported the only means of deciding the race or nationality, besides the color distinction, is the item of nativity, which should in such case be used, although it is of little value as regards young children.

If a city publishes this table or set of tables and nothing else, it will be of the greatest value for statistical and sanitary purposes.

V. The second table to be *compiled* should show the number of deaths from each cause, and the number of deaths at certain ages, by months, with distinction of sex. In most cases, however, it will not be worth while to publish this compilation in full, since in regard to many causes of death season has little influence, and the probabilities of any useful increase to knowledge from comparison of mortality statistics with monthly means of temperature, humidity, barometric pressure, and other meteorological data, is, as regards most diseases, very slight.

A form for a table of this kind, such as we would recommend for publication, is appended, marked Table II.

The compilation form for table No. I may be combined with the form for table No. II in one large compilation-sheet by placing the list of causes of disease in a column between columns for months and those for age.

VI. The third table which we advise should show the relations of causes of death to social relations, *i. e.*, to marriage and to occupations. A form for this purpose is appended, marked Table III.

With this we close our recommendations of forms for municipal mortality statistics. The forms recommended are not intended to exclude other methods of tabulation. They give the minimum amount of mortality statistics which a city should publish. If it gives these together with its population, the health of its people can be compared with that of other localities, which is the great object of the statistician and the reason why uniformity in the forms of tabulation is so very desirable. To enable the statistician to compare the health of the same city at different periods it will often be necessary to continue compilations according to forms already in use, but this should not prevent the use of the forms which are here recommended and which are intended to secure the means of comparison with other places. We have said nothing about tabulation by wards or districts, as we shall have to consider tabulation by localities when speaking of forms for States, &c., and we have not alluded to or provided for the presentation of the results in terms involving ratios, either to living population, to birth-rate, or to total death-rate, because we are stating the essential and minimum amount of work to be done by the local statistician, but we think it highly desirable that such computations of percentages and ratios should be made and published in the local reports as a means of educating not only the people, but the compiler.

The forms of tables for compiling and publishing the mortality statistics for States

are governed by the same principles as those for cities, but another factor enters into them to a much greater extent, viz, locality. The unit of area for this purpose in a State should be at least the county or its equivalent (as the parish in Louisiana), and in many cases smaller subdivisions into towns, townships, &c., will be desirable. Whatever unit may be taken the first thing to be done is to obtain for each of them those compilation tables specified as a minimum for the cities; that is, tables 1, 2, &c. Having done this, the next step is to calculate for each locality or unity of area the ratio of the deaths to the estimated living population, and the total number of deaths for the following classes, viz, for deaths under one year of age, deaths under five years of age, and deaths from about twenty of the principal causes or groups of causes.

A comparison of these results will indicate the localities in which further study and special compilation will be desirable. The tabulation of the mortality statistics for the whole State should be, first, the same table as No. 1 for a city; second, the same as No. 2 for a city; third, the same as No. 3 for a city; fourth, a table showing comparison of number of births and deaths.

With regard to classification by localities in a State, there should be a table giving the total number of deaths for each locality by age, sex, and month, and a table giving the number of deaths from each of the twenty principal causes or groups of causes of deaths for each locality. It will be understood that what we are here advising for a State is the minimum amount of statistical information which it should furnish with regard to its mortality, and the same remarks apply to this as to reports for a city above referred to.

The "report on a uniform plan for registration reports of births, marriages, and deaths," presented to the American Medical Association, in 1859, by a committee of which Dr. Sutton of Kentucky was chairman, should also be consulted by registrars of vital statistics. The forms of tables for reporting deaths, given in that report, are mainly taken from the Massachusetts reports of 1854, and do not seem as desirable as those recommended in this report.

We advise all those engaged in tabulating mortality reports for a city to study the forms of tables used in the city of Providence and in the District of Columbia. And in like manner those upon whom rest the responsibility for tabulating the mortality statistics of a State should especially study the forms of tables used in the last registration report of Massachusetts, the last registration report of Michigan, and the last annual report of the registrar-general of England, in which will be found additional forms and many suggestions of value.

As a matter of convenience, we have had prepared and append herewith outlines of the principal forms contained in these reports.

All of which is respectfully submitted.

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EDWIN M. SNOW, M. D.,
Superintendent of Health and City Registrar, Providence, R. I.

Dr. JAMES L. CABELL,
President National Board of Health.

APPENDIX A.

NATIONAL BOARD OF HEALTH,
Washington, D. C., October 18, 1880.

SIR: I have the honor to transmit herewith a communication from the committee on nomenclature, appointed by the National Board of Health, United States, submitting suggestions with regard to the revision of the nomenclature of the college, and respectfully request that it may laid before the committee of the college charged with revision.

Dr. Charles F. Folsom, a member of this committee, will probably be in London in November next, and it is hoped that he will have an opportunity of meeting the committee of the college and of making further explanation.

Very respectfully, your obedient servant,

J. S. BILLINGS,
Surgeon U. S. Army, Chairman.

HENRY A. PITMAN,
Registrar of the Royal College of Physicians, London, England.

WASHINGTON, D. C., *October* 20, 1880.

The committee appointed at the conference of registrars of vital statistics, called by the National Board of Health in Washington May 6, 1880, to suggest the principal additions to and changes in the nomenclature of the Royal College of Physicians of London which seem most desirable at the present time, and to confer with the committee of the college in charge of revision of said nomenclature with reference to the obtaining of a uniform system for Great Britain and this country, respectfully submit the following suggestions:

I. The synonyms of the new nomenclature should be made as complete as possible, so that any name of a disease which might be used by a physician educated anywhere in Europe may be found in the index. This is especially desirable in this country, where we have physicians from all parts of Europe. The appended list of names of diseases, which are not found in the index to the nomenclature of the college, is submitted in this connection.

II. Malaria, as producing intermittent and remittent fevers and other similar affections, is an important subject of nomenclature and nosological classification in a large part of this country, and it is desirable that this group should be brought together and made distinct.

III. It is advised that the committee consider in the new nomenclature whether a step might not be taken towards establishing a distinction between what may be termed clinical and pathologico-anatomical nomenclature, the first being names of symptoms or groups of symptoms, the second of results of disease. Such a step might be the direction that certain terms, such as posterior spinal sclerosis, cancer of the pancreas, &c., shall be used only to express the result of a post-mortem examination; while certain other terms are to be used only in the absence of such an examination, as is directed in the present nomenclature of the college with regard to encephalitis.

IV. It is considered that the groups of "General Diseases A" and "General Diseases B" are too large for any practical purpose. One of the chief uses of a classification of diseases in such a nomenclature is to enable registrars of vital statistics to summarize certain facts with regard to causes of death. But the classification which is of value to the student of sanitary science is that which is, as far as possible, based on etiology.

From the point of view of the sanitarian, to group small-pox, remittent fever, and typhoid fever together, simply renders valueless the statistics; and the same may be said of the placing together rheumatism, syphilis, cancer, and phthisis.

It is believed that both Group A and Group B can be so subdivided as to be much more convenient for registration and summarizing than they now are, and for this purpose the following scheme is submitted (A):

The only points in which this scheme varies essentially from the plan of the present nomenclature is in the introduction of the group of "diarrhœal diseases," and in the placing with syphilis the other venereal diseases. We do not attempt to go into details with regard to the rearrangement of the local diseases, which will require in many places additions and transpositions to make them correspond to the present state of medical science and to the nomenclature in use by specialists.

We append, however, as a suggestion, and as a part of this report, papers which have been prepared at the request of the committee by specialists, as follows, viz:

1st. Nomenclature of diseases of the eye and ear, by Dr. Swan M. Burnett, Washington, D. C.

2d. Nomenclature of diseases of the nervous system, by Prof. H. C. Wood, of Philadelphia, Pa.

3d. Nomenclature of diseases of the female urinary and generative organs, by Dr. James R. Chadwick, Boston, Mass.

All of which is respectfully submitted.

JOHN S. BILLINGS,
Surgeon, U. S. Army.
THOMAS J. TURNER,
Medical Director, U. S. Navy.
P. H. BAILHACHE,
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Proposed subclassification or grouping of "General Diseases A" and "General Diseases B."

GENERAL DISEASES A.

GROUP 1.—Cholera. Yellow fever. Plague. } Deaths from each of these diseases will be reported separately.

GROUP 2.—Small-pox.
Scarlet fever.
Measles.
Rötheln.
Mumps.
Whooping-cough.
GROUP 3.—Diphtheria.
GROUP 4.—Typhus fever.
Typhoid fever.
Cerebro-spinal fever.
Relapsing fever.
GROUP 5.—Malarial fevers.
Malarial cachexia.
Dengue.
GROUP 6.—Diarrhœa, acute.
Diarrhœa, chronic.
Cholera morbus.
Cholera infantum.
GROUP 7.—Erysipelas.
Pyæmia or septicæmia.
Puerperal fever.
Hospital gangrene.
GROUP 8.—Glanders, or farcy.
Charbon, or malignant pustule.
Contagious aphthæ.
Milk sickness.
GROUP 9.—Influenza.

GENERAL DISEASES B.

GROUP 1.—Rheumatism—Gout.
GROUP 2.—Venereal diseases—Syphilis.
Chancroid.
Gonorrhœa.
GROUP 3.—Cancer and tumors.
GROUP 4.—Tubercular diseases.
GROUP 5.—Rickets, cretinism, scurvy, purpura, hœmophilia, anæmia, chlorosis.
GROUP 6.—Diabetes.
GROUP 7.—Leprosy.
GROUP 8.—Beri-Beri.

LIST OF NAMES OF DISEASES NOT GIVEN IN THE INDEX OF THE NOMENCLATURE OF THE ROYAL COLLEGE OF PHYSICIANS.

Abscess perinephritic.
Abscess peri-prostatic.
Adenoma.
Aphasia.
Athetosis.
Anosmia.
Blepharoptosis.
Blepharospasmus.
Compression of brain.
Congestion of brain.
Compression of cord.
Congestion of kidney.
Chloasma.
Chorion, cystic disease of.
Cellulitis.
Coccoygodynia.
Cylindroma.
Diabetes insipidus—polyuria, polydipsia.
Dura mater, ossification of.
Dipsomania.
Dyspareunia.
Dysidrosis.
Diplacusis.
Empyema.
Entero-colitis.
Epulis.
Ecchymosis.
Eclampsia infantum.
Ebriositas.
Fibroma.
Fever typho-malarial.
Fragilitas ossium.
Giant-celled sarcoma.
Glioma.
Glosso-labial paralysis—bulbar paralysis
Hæmoglobinuria.
Hæmophila—hæmorrhagic diathesis.
Hæmorrhagic remittent fever.
Headache—cephalalgia.
Hydatids, uterine.
Hemicohrea.
Hysterotomy.
Heat stroke—thermic fever, insolatio, ictus solis.
Inflammation of kidney—nephritis.
Keloid.
Lung, acute congestion of.
Laceration of cervix uteri (parturition).
Lymphoma.
Meningeal apoplexy.
Milk sickness.
Myxoadenoma.
Myoma.
Noma.
Nostalgia.
Nausea marina—sea-sickness.
Oöphorectomy.
Othæmatoma.
Oxaluria.
Pachymeningitis.
Peri-hepatitis.
Peri-nephritis.
Peri-prostitis.
Proctitis.
Peri-typhilitis.
Physometra.
Pleurodynia.
Pharyngitis, acute.
chronic.
Psammoma.

Rötheln—rubeola germanica.
Stricture of ureter.
Sarcoma.
Sclerema.
Sclerosis.
Spinal irritation.
Stammering—balbuties.
Thecitis—inflammation of the sheaths of tendons.
Traumatic fever.
Verrugas.
Xanthelasma.

Add to "conditions not necessarily associated with general or local diseases":
Obesity.
Stuttering.
Malingering.
Starvation—fames.
Add to alcoholism { acute. chronic.
Drunkeness.

Local injuries.—Add to the general note, page 191, the following: "Also whether punctured, lacerated, incised, contused, poisoned, or gun-shot."

Under *Neuralgia* state the locality or nerve affected.

Instead of giving a *list* of poisonous substances, under the head of poisons, insert the note: "In returning cases of poisoning the precise agent and mode of administration should be stated."

In diseases like diarrhœa, dysentery, bronchitis, etc., which may occur in an acute form, or as a distinct disease in a chronic form, the word "acute" or "chronic" should be stated.

A NOMENCLATURE OF OPTHALMOLOGY AND OTOLOGY, BY DR. SWAN M. BURNETT, WASHINGTON, D. C.

In making a nomenclature of opthalmology and otology to be used by English-speaking people and by non-specialists as well as specialists, it is often a matter of difficulty to select the proper term for certain affections.

For a universal nonenclature the Latin terms would, of course, be by far the most desirable, since this is the universal language of science; but to employ it in this instance altogether would, we fear, defeat the object we have in view. We have, therefore, always employed, wherever practicable, the English words, only taking the Lain or Greek where the terms used are so common and well understood as to be properly considered as anglicised, or where they offered the advantage of decided brevity and compactness.

As far as possible we have tried to make the specific name of the disease correspond to the known or supposed pathology of the affection, though, in deference to past usages, we have in some cases at the same time given the name furnished by other characteristics. Thus: We have given, in addition to *Conjunctivitis, purulent*, *C. gonorrheal*, to indicate its special cause, and *C. of the new born*, because this has for years been spoken of as a specific form of purulent conjunctivitis. Of course it has not been possible to give every name a disease has been or is even now known by, but we think that it is possible to properly classify any affection of the eye or ear under some name to be found in the following nomenclature.

JUNE 18, 1880.

AFFECTIONS OF THE CHOROID AND VITREOUS HUMOR.

Choroiditis, areola.
Choroiditis, exudative.
Choroiditis, disseminate.
Choroiditis, plastic.
Choroiditis, purulent.
Choroiditis, serous.
Choroiditis, spongy (gelatinous).
Choroiditis, syphilitic.
Chorio-retinitis.
Coloboma of the choroid.
Detachment of the choroid.
Formation of bone in the choroid.
Foreign bodies in the vitreous humor.
Hemorrhage into the choroid.
Hyperæmia of the choroid.
Inflammation of the vitreous humor (hyalitis.)
Opacities of the vitreous.
Persistent hyaloid artery.
Rupture of the choroid.
Tubercles in the choroid.
Tumors of the choroid.
Sclerotico-choroiditis.
Synchesis of the vitreous humor.

AFFECTIONS OF THE CONJUNCTIVA.

Apoplexy of the conjunctiva (ecchymosis).
Burns of the conjunctiva.
Chemosis.
Conjunctivitis, catarrhal.
Conjunctivitis, croupous.
Conjunctivitis, diphtheritic.
Conjunctivitis, follicular.
Conjunctivitis of the globe.
Conjunctivitis of the lids.
Conjunctivitis of the new-born.
Conjunctivitis, phlyctenular.
Conjunctivitis, purulent.
Conjunctivitis, pustular.
Conjunctivitis, trachomatous.

Emphysema of the conjunctiva.
Encanthis.
Hyperæmia of the conjunctiva.
Lithiasis of the conjunctiva.
Metallic stains.
Parasites in the conjunctiva.
Perikeratitic hypertrophy of the conjunctiva.
Pinguecula.
Pterygium.
Trachoma.
Tumors of the conjunctiva.
Ulcer of the conjunctiva.
Wounds of the conjunctiva.
Xerosis of the conjunctiva.

AFFECTIONS OF THE CORNEA.

Abscess of the cornea.
Abrasion of the cornea.
Fistula of the cornea.
Foreign bodies in the cornea.
Hernia of the cornea.
Hydrophthalmus.
Hypopyon.
Keratitis, diffuse,
Keratitis, bullosa.
Keratitis, fascicular.
Keratitis, neuro-paralytic.
Keratitis, pannous.
Keratitis, parenchymatous (interstitial).
Keratitis, phlyctenular.
Keratitis, punctate (pyramidal).
Keratitis, purulent.
Keratitis, traumatic.
Keratitis, vesicular. (Herpes.)
Kerato-conus.
Kerato-globus.
Kerato-Iritis.
Kerato-malacia.
Leucoma-adherens.
Leucoma of the cornea.
Macula of the cornea.
Onyx.
Pannus, crassus.
Pannus, tenuis.
Resorption ulcer of the cornea.
Sclerosis of the cornea.
Serpent ulcer of the cornea.
Sloughing of the cornea.
Staphyloma of the cornea.
Tumor of the cornea.
Ulcer of the cornea.
Wounds of the cornea.

GLAUCOMA.

Glaucoma, acute.
Glaucoma, absolute.
Glaucoma, chronic.
Glaucoma, fulminans.
Glaucoma, hemorrhagic.
Glaucoma, imminent.
Glaucoma, inflammatory.
Glaucoma, secondary.
Glaucoma, simple.
Glaucoma, sympathetic.
Glaucomatous degeneration.
Essential phthisis bulbi.

AFFECTIONS OF THE IRIS AND CILIARY BODY.

Corectopia.
Cyclitis, plastic.
Cyclitis, purulent.
Cyclitis, serous.
Cyclitis, sympathetic.
Exclusion of the pupil.
Foreign bodies in the iris.
Gumma of the iris.
Hernia of the iris.
Hypophæma.
Irido-choroiditis, plastic.
Irido-choroiditis, purulent.
Irido-choroiditis, spongy (gelatinous).
Irido-choroiditis, serous.
Irido-cyclitis plastic.
Irido-cylclitis purulent.
Irido-cyclitis serous.
Irido-cyclitis sympathetic.
Iritis, arthritic.
Iritis, gonorrheal.
Iritis, plastic.
Iritis, purulent.
Iritis, rheumatic.
Iritis, serous.
Iritis, spongy (gelatinous).
Iritis, sympathetic.
Iritis, syphilitic.
Iritis, traumatic.
Iritis, tuberculous.
Iridiremia.
Mydriasis.
Myosis.
Occlusion of the pupil.
Reversion of the iris.
Rudimentary iris.
Rupture of the iris.
Synechia anterior.
Synechia posterior.
Tremulous iris.
Tumors of the iris.
Wounds of the iris.

AFFECTIONS OF THE LACHRYMAL APPARATUS.

Atresia of the puncta.
Dacryo-adenitis.
Dacryo-cystitis, catarrhal.
Dacryo-cystitis, purulent.
Double-punctum.
Dacryo-lithiasis.
Eversion of the puncta.
Exostosis of the nasal duct.
Fistula of the lachrymal sac.
Foreign bodies in the punctum.
Polypus of the lachrymal sac.
Stillicidium lachrymarium (Epiphora).
Stricture of the nasal duct.

AFFECTIONS OF THE LENS.

Aphakia,
Cataract, accreted.
Cataract, anterior polar (pyramidal).
Cataract, axial.
Cataract, calcareous.

Cataract, capsular.
Cataract, complete.
Cataract, congenital.
Cataract, cortical.
Cataract, diabetic.
Cataract, fusiform (spindle-shaped).
Cataract, hard.
Cataract, hypermature.
Cataract, incipient.
Cataract, incomplete.
Cataract, lamellar (zonular).
Cataract, membranous.
Cataract, morgagnian.
Cataract, nuclear.
Cataract, posterior polar.
Cataract, punctate.
Cataract, secondary.
Cataract, senile.
Cataract, soft.
Cataract, spurious.
Cataract, traumatic.
Coloboma lentis.
Dislocation of the lens.
Phakitis.
Lenticonus.
Subluxation of the lens.

AFFECTIONS OF THE LIDS.

Ablepharon.
Abscess of the lids.
Acarus folliculorum.
Acne moluscum.
Ankyloblepharon.
Anthrax of the lids.
Blepharitis marginalis.
Blepharo adenitis.
Blepharo spasm.
Blepharo phymisis.
Chalazion.
Chromhydrosis (Blepharal melasma).
Coloboma palpebrarum.
Distichiasis.
Ectropion.
Elephantiasis palpebrarum.
Emphysema.
Entropion.
Epicanthus.
Erythema of the lids.
Hæmophthalmus externus.
Hæmatidrosis.
Herpes of the lids.
Hordeolum.
Hyperæmia of the lids.
Hyperidrosis.
Infiltration of the lids.
Lagophthalmus.
Nictitation.
Paralysis of the orbicularis.
Phthiriasis ciliarum.
Ptosis atonic.
Ptosis congenital.
Ptosis paralytic.
Seborrhœa.
Tarsitis.
Trichiasis.
Tumors of the lid.
Verrucca of the lids.
Xanthelasma of the lids.

AFFECTIONS OF THE MUSCLES OF THE EYE.

Blepharo spasm.
Enopthalmus spastic.
Insufficiency of the internal rectus.
Insufficiency of the external rectus.
Laceration of the ocular muscles.
Nystagmus, atonic.
Nystagmus, oscillating.
Nystagmus, rotating.
Nystagmus, tonic.
Ophthalmoplegia externa (paralysis of all external muscles of the eye).
Ophthalmoplegia interna (paralysis of all the internal muscles of the eye).
Paralysis of the ciliary muscles (cycloplegia).
Paralysis of the external rectus muscle.
Paralysis of the inferior rectus muscle.
Paralysis of the internal rectus muscle.
Paralysis of the inferior oblique muscle.
Paralysis of the levator palpberæ.
Paralysis of the motor oculi communis.
Paralysis of the obicularis.
Paralysis of the superior oblique.
Paralysis of the superior sectus.
Spasm of the ciliary muscle.
Strabismus, bilateral.
Strabismus, concomitant.
Strabismus, convergent.
Strabismus, divergent.
Strabismus, downward.
Strabismus, monolateral.
Strabismus, paralytic.
Strabismus, upward.

AFFECTIONS OF THE ORBIT AND GLOBE.

Abscess of the orbit.
Argyria oculi.
Caries of the orbit.
Cellulitis of the orbit.
Dislocation of the eyeball.
Effusion of blood in the orbit.
Emphysema of the orbit.
Fracture of the orbital bones.
Inflammation of the frontal sinus.
Necrosis of the orbital bones.
Periostitis of the orbit.
Panophthalmitis.
Tenonitis.
Tumor of the orbit.

ANOMALIES OF REFRACTION, ACCOMMODATION, AND VISION.

Achromatopsia.
Amaurosis.
Amaurosis, hysterical.
Amaurosis, partial, transient.
Amaurosis, without ophthalmoscopic signs.
Amblyopia, alcoholic.
Amblyopia, congenital.
Amblyopia, central.
Amblyopia, saturnine.
Amblyopia, tobacco.
Amblyopia, toxic.
Amblyopiae, anopsia (from non-use).

Amblyopia, hysterical.
Anisometropia.
Asthenopia, accommodative.
Asthenopia, muscular.
Asthenopia, retinal.
Astigmatism, compound (myopic or hypermetropic).
Astigmatism, irregular.
Astigmatism, mixed.
Astigmatism, regular.
Astigmatism, simple (myopic or hypermetropic).
Blue-yellow blindness (*Hering*).
Chromatopsia.
Dyschromatopsia (feeble color-sense).
Flittering scotoma.
Green blindness.
Hemeralopia.
Hemianopsia, inferior.
Hemianopsia, left.
Hemianopsia, right.
Hemianopsia, superior.
Hypermetropia, axial.
Hypermetropia, from deficient curvature of the refracting surfaces.
Hypermetropia, acquired.
Hypermetropia, latent.
Macropsia.
Metamorphopsia.
Micropsia.
Muscae volitantes.
Myopia, axial.
Myopia, acquired.
Myopia, from excessive curvature of the refracting surfaces.
Myopia, false.
Nyctalopia.
Photopsia.
Polyopia, monocular.
Red-blindness.
Red-green blindness (*Hering*)
Scotoma.
Snow-blindness.
Violet-blindness.

AFFECTIONS OF THE RETINA AND OPTIC NERVE.

Amaurotic cat's-eye.
Apoplexy of the retina.
Atrophy of the optic nerve.
Atrophy of the optic nerve, progressive.
Chorio-retinitis, diffuse.
Chorio-retinitis, disseminated.
Chorio-retinitis, circumscribed.
Commotio retinæ.
Cystic degeneration of the retina.
Detachment of the retina.
Dropsy of the optic nerve-sheath.
Epilepsy of the retina.
Embolism of the central artery of the retina.
Embolism of a branch of the central artery of the retina.
Effusion under the retina.
Excavation of the optic disk.
Foreign bodies in the retina.
Hyperæmia of the retina.
Ischæmia of the retina.
Neuro-retinitis.

Neuro-retinitis, ascending.
Neuro-retinitis, descending.
Neuritis, syphilitic.
Œdema of the retina.
Opaque optic nerve fibers.
Papillitis (choked disk).
Peripapillary degeneration of the retina.
Perineuritis, optic.
Perivasculitis, retinal.
Retinitis, albumenuric.
Retinitis, central.
Retinitis, central recurring.
Retinitis, chronic.
Retinitis, circumpapillary.
Retinitis, circumscribed.
Retinitis, diabetic.
Retinitis, diffuse.
Retinitis, hemorrhagic.
Retinitis, leucæmic.
Retinitis, nyctalopic.
Retinitis, oxaluric.
Retinitis, pigmentary.
Retinitis, proliferating.
Retinitis, pernicious anemic.
Retinitis, sympathetic.
Retrobulbar optic neuritis.
Torpor of the retina.
Tumors of the retina.

AFFECTIONS OF THE SCLEROTIC.

Anterior scleral staphyloma.
Episcleritis.
Foreign bodies in the sclera.
Posterior scleral staphyloma.
Scleritis.
Wounds of the sclera.

AFFECTIONS OF THE EXTERNAL EAR.

Congelation of the auricle.
Eczema of the auricle.
External auditory canal, atresia of.
External auditory canal, circumscribed inflammation of.
External auditory canal, condylomata in.
External auditory canal, diffuse inflammation of.
External auditory canal, exostosis of.
External auditory canal, foreign bodies in.
External auditory canal, hyperostosis of.
External auditory canal, polypus in.
External auditory canal, pruritus of.
External auditory canal, ulceration of.
External auditory canal, vegetable fungous growths in.
Inspissated cerumen.
Inflammation of the auricle.
Malformations of the auricle.
Perichondritis.
Tumors of the auricle.
Wounds of the auricle.

AFFECTIONS OF THE MIDDLE EAR AND MEMBRANA TYMPANI.

Anchylosis of the ossicles.
Caries of the temporal bone.
Exfoliation of the temporal bone.
Fracture of the malleus handle.

Membrana tympani, acute inflammation of.
Membrana tympani, adhesion of to the promontory.
Membrana tympani, calcareous deposits in.
Membrana tympani, chronic inflammation of.
Membrana tympani, destruction of.
Membrana tympani, ecchymosis of.
Membrana tympani, formation of bone in.
Membrana tympani, injuries to.
Membrana tympani, perforation of.
Membrana tympani, rupture of.
Mastoid cells, catarrhal inflammation of (primary).
Mastoid cells, catarrhal inflammation of (secondary).
Mastoid cells, periostitis of (primary).
Mastoid cells, periostitis of (secondary).
Mastoid cells, suppurative inflammation of (primary).
Mastoid cells, suppurative inflammation of (secondary).
Middle ear, acute catarrhal inflammation of.
Middle ear, acute suppurative inflammation of.
Middle ear, caries and necrosis of the walls of.
Middle ear, chronic catarrhal inflammation of.
Middle ear, chronic suppurative inflammation of.
Middle ear, exostosis of.
Middle ear, hemorrhage into.
Middle ear, hyperostosis of.
Middle ear, polypus in.
Middle ear, proliferous inflammation of.
Middle ear, tumors in.
Myringomycosis.
Necrosis of the temporal bone.
Otalgia.

AFFECTIONS OF THE INNER EAR.

Boiler-maker's deafness.
Deafmutism.
Deafness to certain tones.
Double hearing with both ears.
Inflammation of the labyrinth, primary.
Inflammation of the labyrinth, secondary.
Ménières complex of symptoms.
Nervous deafness.
Restricted range of audition.
Tinnitus aurium.

OPERATIONS ON THE EYE.

On the conjunctiva.

For pterygium.
Removal of tumors.
Removal of foreign bodies.
Syndectomy (peritomy).

On the cornea and anterior chamber.

Ablation of staphyloma.
For serpent ulcer of the cornea (*Sämisch*).
Paracentesis of the cornea.
Removal of foreign bodies from the cornea.
Removal of tumors from the cornea.
Removal of foreign bodies from the anterior chamber.
Tattooing of the cornea.

On the globe and orbit.

Enucleation of the globe.
Exenteratio orbitæ.
Extraction of foreign bodies from the interior of the eye.
Neurectomy.
Optico-ciliary neurotomy.
Paracentesis of the walls of the globe.
Puncture of the optic-nerve sheath.
Removal of tumors from the orbit.
Removal of tumors from the optic nerve.
Sclerotomy.

On the lids.

For ankylobepharon.
Blepharoplasty.
For destruction of the hair follicles.
For ectropion.
For entropion.
For enlargement of the palpebral opening.
For evacuation of cysts.
For excision of piece of tarsal cartilage.
For ptosis.
For removal of tumors.
For removal of hair bulbs.
For removal of the tarsal cartilage.
For the restoration of lid.
For symblepharon.
For tarsorrhaphy (diminishing of the palpebral opening.
For trichiasis.
Transplantation of the cilia.

On the muscles.

Tenotomy of the muscles (strabotomy).
Advancement of a muscle.
Excision of a piece of a muscle.

On the iris.

Corelysis (Streatfield).
Detachment of posterior synechia (*Passavant*).
Iridectomy.
Iritomy.
Irito-ectomy.
Indodesis.
Removal of foreign bodies from the iris.

On the lachrymal apparatus.

Destruction of the lachrymal sac.
Division of stricture of the nasal duct.
Enlargement of the punctum.
Opening of the lachrymal sac.
Probing the nasal duct.
Removal of the lachrymal gland.
Slitting up the canaliculus.

On the lens.

For depression of cataract (couching).
For extraction of cataract by the flap method.
For extraction of cataract by the Gräfe method.
For extraction of cataract in the capsule.

For extraction of cataract by the linear method.
For extraction of cataract by the Weber method.
For extraction of cataract by the sclero-corneal flap method.
For scoop extraction.
For secondary cataract.
For solution of cataract.
For removal of cataract by suction.

OPERATIONS ON THE EAR.

Catheterization of the eustachian tube.
Dilatation of the eustachian tube.
Division of the tensor tympani.
Excision of the malleus.
Insertion of artifical drum-head.
Myringo-plasty.
Paracentecis of membrana tympani.
Removal of granulations from external or middle ear.
Removal of foreign bodies from external or middle ear.
Removal of tumors from external or middle ear.
Removal of carious or necrosed bone.
Removal of tumors from the auricle.
Removal of polypi.
Trephining or puncturing the mastoid process.
Wilde's incision.

SUGGESTIONS FOR NOMENCLATURE OF DISEASES OF THE NERVOUS SYSTEM, BY H. C. WOOD, M. D., PROFESSOR OF THERAPEUTICS, UNIVERSITY OF PENNSYLVANIA.

1. Encephalitis.
   A. Cerebritis—inflammation of the brain.
   B. Meningitis.
      1. Inflammation of dura mater.
      2. Inflammation of pia mater and arachnoid.
      3. Tubercular meningitis (acute hydrocephalus).
      4. Chronic hydrocephalus.
2. Red softening of the brain (inflammation of brain).
3. Yellow softening of the brain.
4. White softening of the brain (atrophic softening).
5. Abscess of brain.
6. Atropy of brain.
7. Hypertrophy of brain.
8. Apoplexy.
   a. Congestive.
   b. Sanguineous (cerebral - hemorrhage).
   c. Serous.
9. Multiple cerebral sclerosis.
10. Parasitic disease.
11. Malformations.
12. Syphilitic disease.
13. Cancer.
14. Tumors—according to classification.
15. Tubercular deposit.
    a. Miliary or granular tubercle.
    b. Yellow tubercle.
16. Inflammation of the sinuses of the dura mater.
17. General paralysis—paresis.
18. Sunstroke, thermic fever, insolatio, ictus solis.
19. Cerebro-spinal fever.
20. Multiple cerebro-spinal sclerosis.
21. Diseases of the cerebral arteries.
    a. Fatty and calcareous degeneration (atheroma, ossification).
    b. Aneurism, simple miliary.
    c. Impaction of coagula.
    d. 1. Thrombosis—local coagula.
       2. Embolism—coagula conveyed from a distance.

Diseases of the spinal cord and its membranes.

1. Inflammation.
2. Spinal meningitis.
   a. Acute.
   b. Chronic.
3. Spinal concussion.
4. Spinal hemorrhage.
   a. Into the cord. Spinal apoplexy.
   b. Into the cord membranes.
5. Acute spinal congestion.
6. Myelitis.
   a. Acute.
   b. Chronic (with general or local softening).
7. White softening of the spinal cord.
8. Sclerosis of the spinal cord.
   a. Multiple (desseminated sclerosis).
   b. General (sclerosis of more than one region of the cord).
   c. Posterior (locomotor ataxia).
   d. Lateral (spasmodic tabes).
   e. Anterior (tabes dorsalis).
9. Polymyelitis.
   a. Acute (infantile paralysis).
   b. Chronic (progressive muscular atrophy in some of its forms).
10. Acute ascending paralysis.
11. Paraplegia (to be used only when pathology and nature of case is uncertain).
12. Spinal tumors (arranged in accordance with general section).
13. Spinal syphilis.
14. Malformations.

Diseases of medulla oblongata.

1. Inflammation.
   a. Acute.
   b. Chronic.
2. White softening.
3. Apoplexy.
4. Tumors.
5. Glosso-labial pharyngeal paralysis.

Diseases of the nerves.

1. Inflammation, neuritis.
2. Atrophy.
   a. Disseminated neuritis.
   b. Progressive muscular atrophy, one variety.

3. Neuroma.
4. Paralysis, paralysis agitans.
5. Hemiplegia.
6. Paraplegia.
7. Local paralysis.
   a. Facial paralysis.
   b. Scrivener's palsy.
8. Diphtheritic paralysis.
9. Lead palsy.
10. Paralysis following poisoning.
11. Paralysis following acute diseases not of the nervous system.

Functional diseases of the nervous system.

1. Tetanus.
2. Hydrophobia.
3. Infantile convulsions.
4. Epilepsy.
   a. Epileptic vertigo—Petit mal.
5. Convulsions.
6. Spasms of muscle.
7. Laryngismus stridulus—spasmodic croup. Spasm of the glottis. Child-crowing.
8. Shaking palsy.
9. Mercurial tremor.
10. Chorea. (St. Vitus' dance.)
    a. Acute.
    b. Chronic.
11. Chorea major.
12. Hysteria.
13. Spinal irritation.
14. Catalepsy.
15. Syncope.
16. Neuralgia.
    a. Facial—Tic doloreaux.
    b. Brow ague. Hemicrania.
    c. Sciatica.
    d. Pleurodynia.
    e. Irritable stump.
17. Hyperæsthesia.
18. Anæsthesia.
19. Delirium tremens.
20. Hypochondriasis.

Disorders of the intellect.

1. Mania.
   a. Acute.
   b. Chronic.
2. Melancholia.
3. Dementia.
   a. Acute.
   b. Chronic.
4. Idiocy—congenital.
5. Imbecility—congenital.

SUGGESTIONS AS TO DISEASES OF THE FEMALE ORGANS OF GENERATION IN THE UNIMPREGNATED STATE, NUMBERED ACCORDING TO THE NOMENCLATURE OF DISEASES OF THE ROYAL COLLEGE OF PHYSICIANS OF LONDON, BY JAMES R. CHADWICK, M. D., SECRETARY AMERICAN GYNAECOLOGICAL SOCIETY.

Diseases of the ovary. (Page 64.)

No. 631. I question whether it be proper to call *abscess* a distinct disease of the ovary in distinction to *inflammation* when it must be regarded merely as a later stage of the same process or disease (inflammation). The same criticism applies equally to Nos. 643, 651, 672.

Nos. 636, 637. It seems to me important not to suggest different pathological processes in these two terms. I would make them rather 636, "*Simple cystic tumor*," and 637, *complex cystic tumor*, or, better still, have but one term to embrace the two, inasmuch as the *complex tumor* is a later (and accidental) development of the simple cyst.

"*a.* With intracystic growths" makes a distinction, which is of no consequence.

"No. 642. Malformations" hardly seems to include the supernumerary (3d) ovary, recently described and figured by Winckel of Dresden, which should therefore be assigned a special group.

I have an impression that pathologists recognize a "cystic degeneration of the ovary" as something different from the "cystic tumor"; if this be so, the group should also be recognized, as the condition is by no means rare.

"Sarcoma" should be a recognized group, as a number of cases of this disease of the ovary have been placed on record.

Diseases of the fallopian tube.

No. 643. "Abscess." "*Inflammation*" (suppurative, if necessary) would better indicate the pathological process and would be quite as useful from a clinical stand-point. This should be analogous to inflammation of the vagina (vaginitis), &c.

No. "644, Dropsy," and "647, Cyst," I understand as referring to the same pathological condition; if so, one should be stricken out.

No. 649. "Hernia" may occur, but is unknown to me.

Diseases of the broad ligament.

No. 650. "Inflammation:"
a. Pelvic peritonitis.
b. Pelvic cellulitis.

I would omit the qualifying adjective (pelvic) in these two classes as being too comprehensive in its signification. With the adjective the headings *a* and *b* are not merely "varieties" of "inflammation of the broad ligament."

No. 651. "Abscess" is a common disease, but is merely one of the results of inflammation, yet I can see that there may be some necessity and advantage in retaining the group. This case is not analogous to 643; which I regard as very objectionable.

No. 653. "Periuterine or pelvic hematocele." The adjectives here are too comprehensive. The heading had better be simply "hematocele." The word "periuterine" is objectionable, as being a compound of one Greek and one Latin word. Why not "perimetric?" "Lymphangitis" and "varicose veins" should be inserted. The former occurs idiopathically, and likewise as a result of septic absorption. The latter has been recently described in the Boston Medical and Surgical Journal; and quite recently Adelaide Neilson is said to have died of the rupture of a varicose vein in the broad ligament.

Diseases of the uterus, including the cervix.

No. 656. "Granular inflammation." Is not this a variety of "catarrh," the pathological process involved in both being an inflammation of the mucous membrane lining the cavity of the organ (endometritis cervicitis)?

No. 657. "Abrasion" suggests a too rapid action of the causative agent. "Erosion" seems to me a better term.

No. 658. "Ulcer" is a term now pretty generally given up. The only "ulcers" now recognized being malignant or syphilitic.

No. 660. "Utero-vesical fistula" is not comprehensive enough. Make the heading "fistula" with varieties; *a*, utero-vesical; *b*, utero-ureteral; *c*, utero-rectal; *d*, utero-intestinal.

Nos. 661, 662. "Strictures." I would have "stricture of the canal" as principal heading, with varieties: "*a*. stricture of the internal os"; "*b*, stricture of the external os."

No. 665. "Hypertrophy." Would it not be well to recognize two varieties—*a*, subinvolution; *b*, hyperplasia (Thomas)?

No. 666. "Atrophy." Why not make two varieties here: *a*, hyper-involution; *b*, senile atrophy.

"Sarcoma" should be recognized as a group.

"Ecchinococci" should also be recognized. I have seen a case in Germany.

No. 669. "Malformations." Atresia is not mentioned on pp. 124 and 125, though a well-known congenital condition. Lists on pp. 124 and 125 are very imperfect, as will be shown later.

Syphilitic manifestations (chancre on the vaginal portion, &c.) must be indicated. Non-specific warts may occur on the vaginal portion. I have seen them.

Diseases of the vagina.

No. 672. "Abscess" is unknown to me. Abscesses discharging into the vagina and suppurative vaginitis are familiar.

Nos. 674, 675, 676. Better make the chief heading "fistula" with varieties: *a*, vaginal (which, I suppose, refers to fistula running from the vagina to the perineum and other neighboring external parts); *b*, vesico-vaginal; *c*, urethro-vaginal; *d*, uretero-vaginal; *e*, recto-vaginal.

No. 677. "Hernia." Prolapse seems to me a more generally recognized term.

No. 678. "Non-malignant tumors." Varieties of this should be: *a*, "fibroid tumors" (of which I have had one case), and *b*, cysts, a well-known morbid formation.

Sarcoma has, I think, also been described in the vagina.

Vaginismus is omitted.

No. 679 *a*. "Malformations." "Transverse septum" should be recognized (I have lately had a case at the upper part of the canal), and is not referred to on pp. 124, 125.

Non-specific warts sometimes occur throughout the vagina.

Diseases of the vulva.

No. 683. "Abscess." This occurs in the cellular tissue or integument, but especially as a result of inflammation of the vulvo-vaginal (Bartholinus) glands. A separate heading should be made of "Inflammation of the vulvo-vaginal glands." Occlusion of the ducts of these glands often gives rise to a cystic condition of the glands, the contents being occasionally pus; but often (in chronic states) serum. Some classification of these cysts should be made, analogous to cyst or dropsy of the fallopian tube.

Nos. 686, 687. Are not "occlusion" and "imperforate hymen" identical conditions, hence confusing?

(593 *b.*) "Condyloma." This refers, I presume, to non-specific warts.
"Chancroid" should be recognized.
"Laceration" (see 679) should be recognized.

Functional diseases of the female organs of generation.

No. 690. "Amenorrhœa." The following additional varieties should be included:
e. From hyperinvolution of the uterus.
f. From premature menopause.
g. From perverted or deficient nerve power (as seen in those women who, without anemia or other indirect cause, cease to menstruate and grow fat).
Dyspareunia (Barnes) is needed to indicate painful coitus from various causes.
The "hystero-neuroses" are a well-recognized class of diseases, which should not be overlooked; also chloasma uterimum.
"Sterility" should be given.
Masturbation should be given.
Erotomania should be given.

Diseases of the urinary system.

"Acute parenchymatous nephritis," "chronic Bright's disease," both should be given; also, acute or chronic cystitis.

Disorders of the generative system.

No. 697. "Rheumatism of the uterus" seems to me rather a cloak for ignorance, and hence objectionable, than a veritable disease.
No. 698. "Hysteralgia" should, for "partial uterine contractions," be given as a variety of this heading, or of the next (699).
No. 702. "Displacements of the uterus" should have an additional varieties of anteversion, or rather, anterior prolapse of the uterus, described in Germany as "pendulous abdomen." 6. Hernia I don't understand as distinguished from "prolapse." "Separation of the pubic symphysis" needs insertion, and I believe it a pathological condition arising during pregnancy, although generally not recognized until the patient rises from childbed.

AFFECTIONS CONNECTED WITH PREGNANCY.

Disorders of the nervous system.

Should not "nausea and vomiting" be inserted under this heading? "Convulsions" should have two recognized varieties, nervous (hysterical) and eclamptic (uræmic).

Disorders of the circulatory system.

Serous exudation "ascites" is unknown to me as accompanying pregnancy, unless caused by cardiac, hepatic, or venal disease. Embolism, thrombosis, air in the circulatory system, all need mention; perhaps also apoplexy.

Disorders of the digestive system.

"Hernia" I have seen as a complication of pregnancy.

Affections connected with parturition.

No. 708 should read "mechanical obstacle to the *expulsion of the fœtus.*" To the varieties should be added:
"From locked heads of twins," "from pessary in the vagina," "hour-glass contractions of the uterus," "retroflexion of the uterus." I have had a case at time of labor preventing delivery.
No. 715. "Inversions of the uterus" should be transferred to "affections consequent on parturition."
No. 716. "Convulsions" should have as varieties, "*a*, nervous" (hysterical), and "*b*, eclamptic."

Affections consequent on parturition.

No. 132. "Puerperal fever" should have varieties "*a*, septicæmia (pyæmia)," "*b*, peritonitis," "*c*, lymphangitis."

No. 719, with its two varieties, is unnecessary.

Nos. 660, 675, 676 should all be included under "fistulæ" as varieties "*a*, utero-urethral"; "*b*, utero-vesical"; "*c*, utero-intestinal"; "*d*, utero-rectal"; "*e*, vesico-vaginal"; "*f*, vesico-urethral"; "*g*, recto-vaginal."

"Death and putrefacation of the fœtus" might be added, also, "retention of the placenta or membranes," "fissure of the anus," and "fistula in ano."

Diseases of the female breast.

Add "eczema of the nipple," and "galactocele."

Congenital malforations.

Of the female organs of generation, pp. 124, 125.
Ovary, add "supernumerary."
External organs, add "infantile type."

Malformations of uterus.

Uterus duplex and vagina duplex.
Uterus duplex and vagina simplex.
Uterus unicornis.
Uterus bicornis.
Uterus simplex and vagina duplex.
Uterus duplex and vagina duplex, with atressia of one vagina.
Infantile uterus.

ADDENDA.

Addison's disease has been reported as a complication of pregnancy.
After-pains.
Amaurosis.
Amnion, dropsy of.
Chlorosis.
Hystero-epilepsy.
Heart disease in pregnancy.
Herpes in pregnancy.
Lochia offensive.
Parotiditis in pregnancy.
Uterine phlebitis.
Placenta prævia.
Pregnancy conical.
Puerperal lactosuria.
Puerperal pernicious anemia.
Puerperal tetanus.
Puerperal scarlatina.
Rape.
Coccygodynia.
Wolffian body.

APPENDIX B.

[Form of weekly report of mortality to be made on postal card.]

REPORT OF DEATHS IN ____________

for the week ending Saturday noon, ____________ 1880.

[Please note any mortality from unusual causes not specified in this blank. Please report cases of small-pox, and the prevalence, to a great extent, of any disease.]

Causes of death.	Deaths. White.	Deaths. Colored.
Accidents of all kinds		
Cerebro-spinal meningitis		
Consumption (phthisis pulmonalis)		
Croup		
Diarrhœal diseases		
Diphtheria		
Erysipelas		
Fever. Typhoid		
Fever. Malarial		
Fever. Scarlet		
Acute lung diseases. Pneumonia		
Acute lung diseases. Congestion of lungs		
Acute lung diseases. Bronchitis, acute		
Acute lung diseases. Pleurisy		
Measles		
Puerperal diseases		
Small-pox		
Whooping-cough		
Population		
under 5 years		
Deaths from all causes		
Deaths under 5 years		

REMARKS.

(Signature,) ____________

TABLE I.

Cause of death (see note A).	Color (see note B).	Sex (see note C).	Total.	Under 1 year.	1 to 2.	2 to 3.	3 to 4.	4 to 5.	Total under 5.	5 to —	10 to —	15 to —	20 to —	25 to —
Small-pox	White.	Male												
		Female												
	Colored	Male												
		Female												
Measles	White.	Male												
		Female												
	Colored	Male												
		Female												

NOTE A.—To permit of comparison with the tables in the census and in foreign statistical tables, *e. g.*, those of the registrar-general of England, the groups of ages above 5 years should not be larger than by quinquennial periods.

NOTE B.—W., white; C., colored. American, Irish, German, &c., to be added or substituted according to the proportion of these races present.

NOTE C.—It will save space and cost in printing to place the distinctions of race and sex at the side of the page in connection with the name of the disease, as in this table, instead of at the top in connection with the several ages, as is sometimes done.

TABLE II.

Causes of death, &c. (see note A).	Color (see note B).	Sex.	Jan.		Feb.		March.		April.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.	
			Deaths under 5 years.	Total deaths.	Deaths under 5 years.	Total deaths.	Deaths under 5 years.	Total deaths.	Deaths under 5 years.	Total deaths.	Deaths under 5 years.	Total deaths.	Deaths under 5 years.	Total deaths.	Deaths under 5 years.	Total deaths.	Deaths under 5 years.	Total deaths.	Deaths under 5 years.	Total deaths.	Deaths under 5 years.	Total deaths.	Deaths under 5 years.	Total deaths.	Deaths under 5 years.	Total deaths.
Small-pox	White	Male....																								
		Female .																								
	Colored	Male....																								
		Female .																								
Measles	White	Male....																								
		Female .																								
	Colored	Male....																								
		Female .																								

NOTE A.—The following heads are suggested as those which will be most generally used in this column in the table to be published: Small-pox, scarlet fever, measles, whooping-cough, diphtheria, typhoid fever, malarial fevers, erysipelas, diarrhœal diseases, consumption, all other tubercular diseases, rheumatism and gout, diseases of the nervous system, diseases of the circulatory system, croup, pneumonia, acute bronchitis, all other diseases of the respiratory organs, diseases of the digestive organs, diseases of the urinary and generative organs (for each sex), puerperal diseases, total deaths from all diseases, suicide, homicide, accidents and injuries, poisoning, total deaths from all causes.

NOTE B.—American, Irish, German, &c., to be added to or substituted for "white," "colored," according to the proportions of these races present.

TABLE III.

Cause of death.	Social relations.				Occupations.							
	Married.	Single.	Widowed.	Unknown.	Bakers.	Blacksmiths.	Carpenters.	Cultivators of the earth.	Cooks.	Coopers.	* * *	* * *
Small-pox												
Scarlet fever												
* * *												

APPENDIX D.

Forms of tables taken from Registration Reports, the source being indicated on each table as follows, viz:

District of Columbia. From "Report of the Health Officer of the District of Columbia." Washington, 1880.

England. From "Fortieth Annual Report of the Registrar General of Births, Deaths, and Marriages in England." London, 1879.

Massachusetts. From "Thirty-seventh Report to the Legislature of Massachusetts relating to the Registry and Return of Births, Marriages and deaths." Boston, 1879.

Michigan. From "Eighth Annual Report relating to the Registry and Return of Births, Marriages, and Deaths in Michigan." Lansing, 1880.

Providence, R. I. From "Twenty-fifth Annual Report upon the Births, Marriages, and Deaths in the City of Providence." Providence, 1880.

These forms may be conveniently classified as follows, although, of course, the groups overlap, and most of the forms belong in at least two groups.

Group I, including Forms 1 to 5, relates primarily to the causes of death.

Group II, including Forms 6 to 11, relates mainly to the influence of age.

Group III, including Forms 12 to 15, relates mainly to the influence of month or season.

Group IV, including Forms 16 to 20, relates mainly to the influence of race or nativity.

Group V, including Forms 21 to 32, relates mainly to the influence of locality.

Group VI, including Forms 33 to 35, relates mainly to the influence of occupation.

Group VII, including Forms 36 to 50, relates mainly to studies of special diseases.

FORM 1.

Causes of death, by sex and age. England.

Class.	Causes of death.	Males.								Females.							
		All ages.	Ages at death.							All ages.	Ages at death.						
			Total under 1 year.	1	* *	Total under 5 years.	5	* *	95 and upward.		Total under 1 year.	1	* *	Total under 5 years.	* *	* *	95 and upward.
	All causes...........................																
	Specified causes........................																
	CLASSES.																
I	Zymotic diseases........................																
	* * * * *																

In this table the ages are given by single years up to 5, then by groups of 5 years to 25, after that by groups of 10 years.

FORM X.

Causes of death, by sex and month, and by sex and age. Massachusetts.

NOTE.—Michigan uses the same form, but gives the years of ages in groups of five throughout.

Sex.	Deaths.				Months.													Causes of death.	Ages.											
	Sex.																													
	Males.	Females.	Unknown.	Totals.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Unknown.		Under 5.	5 to 10.	10 to 15.	15 to 20.	20 to 30.	30 to 40.	40 to 50.	50 to 60.	60 to 70.	70 to 80.	Over 80.	Unknown.
Females																		Abortion												
Males............																		Abscess												
Females																		....do												
Males............																		* * *												
Females																		* * *												

FORM 3.

Causes of death, by months, color, and sex; by age, color, and sex; and by social relations, color, and sex. District of Columbia.

Cause of death.	Total deaths from each cause.	Per cent. of each cause to total mortality.	Death-rate.		Recapitulation.																18—.															
			Deaths per 100 inhabitants.		Total by color and sex.				Total by color.		Total by sex.		Total under 5 years.				Total.	Per cent. of each cause to total mortality.	July.				* * *				Total first quarter.									
			W.	C.	W.		C.						W.		C.				W.		C.		W.		C.		W.		C.							
					M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.			M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.						
CLASS 1.—ZYMOTIC DISEASES.																																				
Order 1.—Miasmatic.																																				
* * * *																																				
Total miasmatic diseases......																																				

Cause of death.	Age of decedent.									Social relations.									
	Under 1 year.				* * *	5 to 10 years.	10 to 20 years.	* * *	Above 100 years.	Married.				Single.		Widow or widower.		Unknown.	
	W.		C.							W.		C.		W.	C.				
	M.	F.	M.	F.						M.	F.	M.	F.						
CLASS 1.—ZYMOTIC DISEASES.																			
Order 1.—Miasmatic.																			
* * * *																			
Total miasmatic diseases......																			

FORM 4.

Causes of death.—Comparative mortality. Exhibiting the number of deaths from special causes (nosologically arranged) during each of the five years 1874, 1875, 1876, 1877, *and* 1878, *with the number of deaths, annually, to* 100,000 *population; also the number and percentage of deaths during the five years* 1874 *to* 1878, *and during the entire registration period of thirty-seven years and eight months ending December* 31, 1878, *still-births included. Massachusetts.*

Deaths.							Causes of death.	Deaths to 100,000 population.					Percentage of all deaths.	
1874.	1875.	1876.	1877.	1878.	5 years, 1874–'78.	37 years and 8 months ending Dec. 31, 1878.		1874.	1875.	1876.	1877.	1878.	5 years, 1874–'78.	37 years an 8 months ending De 31, 1878.
							All causes Special causes							

FORM 5.

Causes of death registered in Massachusetts for each of the twenty-two years, 1857 *to* 1878.

Class.	Causes of death.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.
	All causes Special causes																						

FORM 6.

Deaths registered at different ages in each of the —— years 18— to 18—; males and females. England.

[NOTE.—Ages given by single years up to 5, then by quinquennial periods to 25, then by decennial periods.]

Total.	All ages.	Ages at death—males.								Year.	All ages.	Ages at death—females.							
		Under 1.	1.	***.	Under 5 years.	5.	***.	95 and upward.	(?)			Under 1.	1.	***.	Under 5 years.	5.	***.	95 and upward.	(?)
18— 18— **																			

FORM 7.

Mortality per 1,000, at twelve groups of ages, in —— years, 18— to 18—; females. England.

Years.	Ages—females.				
	All ages.	0.	5.	*** .	95 and upward.
	Mean of 40 years.				
18— to 18—					
	Means of 10 years.				
18— to 18— 18— to 18—					
	Means of 5 years.				
5 years, 18— to 18— 5 years, 18— to 18— * * * 2 years, 18— to 18—					

* Same distribution of ages as in Form 6.

FORM 8.

Annual rate of mortality per 1,000 *persons living, at twelve groups of ages, in each of the registration counties during* 18—. *England.*

Registration counties.	All ages.	0.	5.	10.	**.	85 and upward.
England. Average annual rate in 25 years, 18— to 18—.						
England, Div. I. London						

Same distribution of ages as in Form 6.

FORM 9.

Exhibiting by sex, and by age in periods of years, the number and proportion of persons returned as having died in ——— during the year 18—; also the excess of persons of each sex. Michigan.

Ages in years and periods.	Number of deaths, 18—.				Per cent. of deaths at each age to total at all ages.			Per cent. of each sex to total of both sexes.				Excess of the sexes by number.		Males to 100 females.
										Excess.				
	Total.	Males.	Females.	Unknown.	Total.	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.	
All ages														
Under 1														
1 to 2														
* * *														
Under 5														
5 to 10														
* * *														
Unknown ages														

FORM 10.

Exhibiting, for the State and counties of ———, the average age of inhabitants of each sex in 18—, the number of deaths returned as having occurred at all ages, from old age, of all aged 70 and over, and of all aged under 5 in 18—; the per cent. of deaths from old age, of all aged 70 and over, and of all aged under 5, to deaths at all ages; also the inhabitants in 18— aged under 5 years, and per cent. to inhabitants at all ages. Michigan.

State and counties.	Average age of inhabitants June 1, 18—.		All ages.	Old age.		Aged 70 and over.		Decedents aged under 5.		Inhabitants in 18— aged under 5.	
	Males.	Females.	Number of deaths, 18—.	Number of deaths.	Per cent. to deaths at all ages.	. . .	. . .	. . .	. . .	. . .	. . .
State.											
A——											
. . .											

FORM 11.

Relation of age to month of death. Michigan.

Deaths, by ages, in periods of years.		Year 18—.	Months.											
			Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
All ages.														
Under 1	Number													
	Per cent. of all ages													
	Per cent. of deaths, 18—													
Under 5	Number													
	Per cent. of all ages													
	Per cent. of deaths, 18—													
5 to 10	Number													
	Per cent. of all ages													
	Per cent. of deaths, 18—													
10 to 20	Number													
	Per cent. of all ages													
	Per cent. of deaths, 18—													
20 to 50	Number													
	Per cent. of all ages													
	Per cent, of deaths, 18—													
50 and over	Number													
	Per cent. of all ages													
	Per cent. of deaths, 18—													
Unknown ages.	Number													
	Per cent. of all ages													
	Per cent. of deaths, 18—													

FORM 12.

Exhibiting, by sex and by months, the number returned as having died in ——, during the year 18—, at each and every age, the age stated in twelfths of a year for those under one, and in years for those over one, year of age. Michigan.

Ages, in years.	Sex.	Year 18—.	Months, 18—.												
			Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Unknown.
Under 1-12	Totals														
	Males														
	Females														
	Unknown														
* * *	* * *														
	* * *														
	* * *														
	* * *														
1	Totals														
	Males														
	Females														
	Unknown														
2	* * *														
	* * *														
	* * *														
	* * *														

FORM 13.

The months of birth and death of children born in 18—, who died under one year of age. Michigan.

Months of births, 18—.	Births, 18—; died under 1 year.	Months of death, 18—.												Months of death, 18—.												Per cent. of decedents aged under 1 month.
		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
Born in 18—; died aged under 1 year																										
January																										
February																										
* * *																										
Deaths at each age. { No. of deaths																										
Deaths at each age. { Ages in months																										

FORM 14.

Season and disease. Providence, R. I.

Causes of death.	January.	February.	March.	First quarter.	April.	May.	June.	Second quarter.	July.	August.	September.	Third quarter.	October.	November.	December.	Fourth quarter.	Whole year.
Accidents (all kinds)																	
Apoplexy																	
Brain, diseases of																	
Bronchitis																	
Cancer (all kinds)																	
Child-birth and puerperal diseases																	
Cholera infantum																	
Cholera morbus																	
Consumption																	
Convulsions																	
Croup																	
Diarrhœa, acute and chronic																	
Diphtheria																	
Dysentary																	
Enteritis																	
Erysipelas																	
Fever, typhoid																	
Heart, diseases of																	
Whooping-cough																	
Hydrocephalus																	
Insanity																	
Intemperance and delirium tremens																	
Kidney, diseases of																	
Liver, diseases of																	
Marasmus																	
Measles																	
Meningitis, cerebro-spinal																	
Old age and senile gangrene																	
Paralysis																	
Peritonitis																	
Pneumonia and congestion of the lungs																	
Scarlatina																	
Suicide																	
Teething																	
Unknown																	
Other causes as given																	
Totals																	

FORM 15.

Deaths by age and parentage in each month 18—. Providence, R. I.

Divisions of the year.	Divisional periods of life.														All ages.
	Under 1.	1 to 2.	2 to 5.	5 to 10.	10 to 15.	15 to 20.	20 to 30.	30 to 40.	40 to 50.	50 to 60.	60 to 70.	70 to 80.	80 to 90.	90 to 100.	
American parentage.															
January															
February															
March															
First quarter															
* * *															
Whole year															
Foreign parentage.															
January															
February															
March															
First quarter															
* * *															
Whole year															
Total American and foreign															

FORM 16.

Deaths in ——— during the year 18—, distinguishing the color by number and proportion of each sex, and by sex, the per cent. of deaths of each color to total of all colors, and per cent. of inhabitants of each color to total of all colors, June 1, 18—. Michigan.

Color.	Sex.	Population June 1, 18—.	Number of deaths returned for 18—.	Per cent. of deaths of each sex to total of both sexes.	Males to 100 females.	Per cent. of deaths of each color to total of all colors by sex.	Per cent. of inhabitants of each color to total of all colors by sex, June 1, 18—.	Death rate—per cent. of deaths in 18— to population in 18—.
All colors	Total							
	Males							
	Females							
	Unknown							
White	* * *							
	* * *							
	* * *							
	* * *							
Black	Total							
	Males							
	Females							
Mulatto	* * *							
	* * *							
	* * *							
Indian	* * *							
	* * *							
	* * *							
Unknown	* * *							
	* * *							
	* * *							
Black and mulatto	* * *							
	* * *							
	* * *							

FORM 17.

Exhibiting, by number and by sex, for the State and counties, the color of all persons returned as having died in —— during the year ending December 31, 18—. Michigan.

State and counties.	All colors, 18—.				White.				Black.			Mulatto.			Indian.			Unknown.			
	Total.	Males.	Females.	Unknown.	Total.	Males.	Females.	Unknown.	Total.	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Unknown.
State																					
A——																					
B——																					
* * *																					

FORM 18.

Number and percentage at different ages, according to parentage. Providence, R. I.

Age.	American parentage, 23 years, 18— to 18—.		Foreign parentage, 23 years, 18— to 18—.		American and foreign parentage, 23 years, 18— to 18—.	
	Number of deaths.	Percentage in each division of age.	Number of deaths.	Percentage in each division of age.	Number of deaths.	Percentage in each division of age.
Under 1 year						
1 and under 2						
2 and under 5						
Total under 5						
5 and under 10						
10 and under 15						
* * *						
90 and over						
Totals						

FORM 19.

Deaths, twenty-three years, 1856 *to* 1878. *Recapitulation: Aggregate and average age by parentage. Providence, R. I.*

Twenty-three years, 1856 to 1878.	American parentage.			Foreign parentage.			Total American and foreign.		
	Number of deaths.	Aggregate age.	Average age.	Number of deaths.	Aggregate age.	Average age.	Number of deaths.	Aggregate age.	Average age.
January									
February									
* * *									
Whole year									

FORM 20.

Difference in years between the average age of American and foreign decedents. Providence, R. I.

Months.	18—.			23 years, 18— to 18—.		
	Average age.		Difference.	Average age.		Difference.
	American.	Foreign.		American.	Foreign.	
January						
February						
* * *						
Whole year						

FORM 21.

Area in statute acres, population, 18—, deaths from several causes, and inquest cases in the year 18—, in the divisions, counties, and districts. *England.*

Divisions and registration counties.	Area in statute acres.	Population, 18—.	Deaths from several causes in 18—.																		Inquests.
			Small-pox.	Measles.	Scarlet fever.	Diphtheria.	Whooping-cough.	Typhus fever.	Enteric or typhoid fever.	Simple continued fever.	Erysipelas.	Metria or puerperal fever.	Childbirth.	Influenza.	Dysentery.	Diarrhœa.	Cholera.	Phthisis, or consumption.	Diseases of respiratory organs.	Violence.	

FORM 22.

Deaths of males from different causes in each of the registration counties in the year 18—. *England.*

Class.	Causes of death.	Males.												
		Division I.			Division II.					Division III.				
	All causes .... Specified causes													
	(CLASSES.) * * *													

Same form as above for females.

FORM 23.

Abstract of marriages, births, and deaths, 18—; marriages, births, and deaths, 18—; ***districts and births and deaths,*** **18—;** ***sub-districts. England.***

Districts and sub-districts.	Area in statute acres.	Population, 18—.	Total.		Births.				Deaths.		Excess of births over deaths.
			Births.	Deaths.	Including illegitimate births.		Illegitimate births.				
					Males.	Females.	* * *	* * *	* * *	* * *	

FORM 24.

Deaths registered in the public institutions of —— in the year 18—. England.

Divisions and registration counties.	Total number of institutions.	Total deaths in all institutions.	Workhouses.				Hospitals.				Lunatic asylums.			
			Number of institutions.	Deaths.			Number of institutions.	Deaths.			Number of institutions.	Deaths.		
				Persons.	Males.	Females.		Persons.	Males.	Females.		Persons.	Females.	Males.
England														
DIVISIONS.														
* * *														
* * *														
* * *														

FORM 25.

Deaths at different ages registered in the year 18— in the divisions and registration counties. England.

	Divisions and registration counties.	Males.										
		Total births.	Total deaths.	Ages at death.								
				Under 1 year.	1 year.	2 years.	* * *	Under 5 years.	5 years.	* * *	* * *	95 years and upward.
	England											
	DIVISIONS:											
I.	* * *											
II.	* * *											

FORM 26.

Births, marriages, and deaths registered during the year 18—. Massachusetts.

Counties and towns.	Population, State census 1875.	Births.									Marriages.						Deaths.						
			Sex.			Parentage.						Nativity.						Sex.				Age.	
		Whole number.	Males.	Females.	Unknown.	American.	Foreign.	American father and foreign mother.	Foreign father and American mother.	Unknown.	Couples.	American.	Foreign.	American mother and foreign father.	Foreign mother and American father.	Unknown.	Persons.	Males.	Females.	Unknown.	Number whose ages are registered.	Aggregate.	Average.
Barnstable																							
Brewster																							
Chatham																							
* * *																							

FORM 27.

Causes of death.—Nosological arrangement exhibiting the number of deaths in each county from special causes (statistically classified) during the year 18—, still births included. Massachusetts and Michigan

Causes of death.	State.	Barnstable.	Berkshire.	Bristol.	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *
All causes														
Specified causes														

FORM 28.

General abstract for the 14 years 1865 to 1878, exhibiting the number of births, marriages, and deaths registered for the several counties and towns of Massachusetts for the 14 years 1865 to 1878, distinguishing the sex of children born and of persons who died in each town, and the average age of those deceased in each county during the period specified. Massachusetts.

State and county.	Births.				Marriages—number of couples.	Deaths.			
	Persons.	Sex.				Persons.	Sex.		
		Males.	Females.	Unknown.			Males.	Females.	Unknown.
MASSACHUSETTS.									
Barnstable									
* * * *									

FORM 29.

Deaths—14 *years*, 1865 *to* 1878—*distinguishing by counties, by months, and by sex the registered number of persons who have died during the* 14 *years* 1865 *to* 1878; *also for the entire State the percentage of the numbers in each month (distinguishing sex) to the total number. Massachusetts.*

Fourteen years—months.	Sex.	Percentage.	State.	Barnstable.	Berkshire.	Bristol.	* *	* *	* *	* *	* *	* *	* *	* *	* *	* *
Fourteen years	Males															
	Females															
	Unknown															
	Totals															
January	Males															
	Females															
	Unknown															
	Totals															
* * *																

FORM 30.

Exhibiting for the State and counties, by sex, the number of deaths returned as having occurred in ——— during the year 18—, and in each month of the year; also the number of deaths at each period of age. Michigan.

State and counties.	Sex.	Year 18—.	Months, 18—.													Ages, 18—.						
			January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Unknown.	Under 5.	5 to 10.	10 to 15.	15 to 20.	20 to 25.	* * *	* * *
State	Total																					
	Males																					
	Females																					
	Unknown																					
A—	Total																					
	Males																					
	Females																					
	Unknown																					
	* * *																					

FORM 31.

Distinguishing by counties, by months, and by sex the registered number of persons who died during the year. Massachusetts.

Year and month.	Sex.	State.	Barnstable.	Berkshire.	Bristol.	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *
Year	Males												
	Females												
	Unknown												
	Total												
January	Males												
	Females												
	Unknown												
	Total												

FORM 32.

Deaths by age, and sex, and by counties and towns, 18—, distinguishing by age and sex the number of deaths registered in each county and town in the State during the year 18—, in connection with the population, distinguishing sex according to the State census of 18—, and also with the percentage of the registered number of deaths to the population. Massachusetts.

State and county.	Population, State census 18—.		Percentage of deaths to population.	Number of deaths registered, 18—.	Under 1.	1 to 2.	2 to 3.	5 to 10.	* * *	95 and over.	Unknown.
Massachusetts		Males									
		Females									
		Unknown									
		Total									
Barnstable		Males									
		Females									
		Unknown									
		Total									

FORM 33.

Distinguishing by occupation (statistically classified) the number, with their average and aggregate ages, of ***persons in the State*** *(in two geographical divisions) whose occupations are specified and whose deaths were registered during the year 1878; also in the State (entire) during the period of 35 years and 8 months, ending with December 31, 1878.*

[This table includes only persons over 21 years of age. Massachusetts.]

Occupations.	Nine eastern counties, 1878.			Five western counties, 1878.			Whole State, 25 years and 8 months, May 1, 1843, to December 31, 1878.		
	Number of persons.	Ages.		Number of persons.	Ages.		Number of persons.	Ages.	
		Aggregate.	Aggregate.		Aggregate.	Aggregate.		Aggregate.	Aggregate.
All classes and occupations.									
I. Cultivators of the earth									
II. Active mechanics abroad									
III. Active mechanics in shops									
IV. Laborers—no special trades									
V. Factors laboring abroad									
VI. * * *									
VII. * * *									
VIII. * * *									
* * *									

FORM 34.

Showing, by occupations, the number of persons having died in ——, with aggregate and average ages. Michigan.

Case.	Occupations, 18—.	Number of persons.	Age, in years.	
			Aggregate.	Average.
	All specified occupations			
I	Cultivators of the earth			
II	Active mechanics abroad			
III	Active mechanics in shop			
IV	Inactive mechanics in shop			
V	Laborers—no special trades			

FORM 35.

Showing the occupation of fathers of children born, of grooms, and of decedents, for the year ending June 30, 18—. *District of Columbia.*

Occupations.	Fathers.		Grooms.		Decedents.			
					White.		Colored.	
	White.	Colored.	White.	Colored.	Male.	Female.	Male.	Female.
Agents								
Bakers								
* * *								

FORM 36.

Deaths from several causes in 18—. *Massachusetts.*

State and county.	Population in 1879.	Deaths from several causes in 1878.																	
		Small-pox.	Measles.	Scarlatina.	Diphtheria and croup.	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *
Massachusetts																			
Barnstable																			
Berkshire																			
Bristol																			

FORM 37.

Deaths in ——— *from ten specified causes during the year* 18—, *exhibiting the number of each sex, total number in each month, and at different periods of age, according to the returns. Michigan.*

Sex, month, and ages.		Ten causes of death in 18—									
		Cancer.	Cephalitis.	Croup.	Diarrhœa.	Diptheria.	Dysentery.	Measles.	Scarlet fever.	Typhoid fever.	Whooping-cough.
Sex	Total										
	Males										
	Females										
	Unknown										
Months	January										
	* * *										
	Unknown										
	Average month										
Ages	Under 5										
	5 to 10										
	* * *										
	80 and over										
	Unknown										

FORM 38.

Cerebro-spinal meningitis, &c.—Deaths returned as having occurred in ——, from cerebro-spinal meningitis, spotted fever, spinal meningitis, meningitis, and spinal fever, by months, during the year 18—, and some meteorological conditions existing at the same time. Michigan.

Months in order by number of deaths from cerebro-spinal meningitis, spotted fever, spinal meningitis, meningitis, and spinal fever, greatest number first.	Deaths from cerebro-spinal meningitis, &c., 18—.		Temperature (Fahr.), mean of three daily observations at 7 a. m., 2 p. m., and 9 p. m.			Humidity of atmosphere, &c., monthly averages.			Ozone—relative maximum=10.		Barometer reduced to 32° Fahrenheit—average.	Rain and melted snow in inches.	Range of barometer.	
			Average range.											
	Number.	Per cent. of total.	Daily.	From day to day, 2 p. m. to 2 p. m.	Temperature.	Relative humidity or per cent. of saturation.	Force or pressure of vapor in inches.	Weight, in grains, of vapor in cubic foot of air.	Day—7 a. m. to 2 p. m.	Night—9 p. m. to 7 a. m.			Monthly and yearly.	Average daily.
Year 18—														
More than average														
April														
March														
* * *														
* * *														
Average:														
July														
October														
* * *														
* * *														

Same table used for croup and for diphtheria.

FORM 39.

Exhibiting for the State and by counties for the year 18— the number of deaths returned as having occurred from all causes—from consumption, from pneumonia, from typhoid fever, from intermittent fever, and from diarrhœa; also the per cent. of deaths from consumption, pneumonia, typhoid fever, intermittent fever, and diarrhœa, to deaths from all causes. Michigan.

State and counties.	Deaths, all causes, 18—.	Consumption.		Pneumonia.		Typhoid fever.		Intermittent fever.		Diarrhœa.	
		Number of deaths.	Per cent. to deaths from all causes.	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *
State											
A—											
* * *											
* * *											

FORM 40.

Exhibiting for the State and geographical divisions in 18—, by sex, the number of deaths returned as having occurred from all causes, from consumption, from pneumonia, from typhoid fever, from intermittent fever, and from diarrhœa; also the per cent. of deaths from consumption, pneumonia, typhoid fever, intermittent fever, and diarrhœa, to deaths from all causes. Michigan.

State and geographical divisions.	Sex.	All causes, 18—.	Consumption.		Pneumonia.		Typhoid fever.		Intermittent fever.		Diarrhœa.	
			Number of deaths.	Per cent. to deaths from all causes.	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *
State	Total											
	Male											
	Female											
	Unknown											
Northern	Total											
	Male											
	Female											
* * * * * *	* * *											

FORM. 41.

Correlation of consumption and pneumonia, exhibiting the number and per cent. of deaths of each sex, the difference between the sexes, and the per cent. of total deaths at each period of age from consumption and pneumonia in ——, during the year 18—. Michigan.

Ages in periods of years.	Deaths from consumption, 18—.								Deaths from pneumonia, 18—.									
	Number.			Per cent. of deaths at each age to deaths at all ages.	Per cent. of the sexes.				Number.				Per cent. of deaths at each age to deaths at all ages.	Per cent. of the sexes.				
							Excess.										Excess.	
	Males.	Females.	Total.		Males.	Females.	Males.	Females.	Males.	Females.	Unknown.	Total.		Males.	Females.	Unknown.	Males.	Females.
All ages																		
Under 5																		
* * *																		
80 and over																		
Unknown																		
Average																		

FORM 42.

Exhibiting, for the year and months, by sex, the conjugal condition, occupation, and age, in periods of years, of all returned as having died from consumption in ——, during the year ending December 31, 18—. Michigan.

Months, 18—.					Year 18—.	Conjugal condition.	Sex and occupation.	Ages, in periods of years, 18—.				
January.	February.	March.	* * *	Unknown.				Under 5.	5 to 10.	* * *	80 and over.	Unknown.
						Total.	Total deaths from consumption.					
						Married						
						Single						
						Widowed						
						Unknown						
						* * *	Females					
						* * *						
						* * *						
						* * *						
						* * *						
						* * *	Males					
						* * *						
						* * *						
						* * *						
						* * *						
						* * *	Occupations unknown—Total					
						* * *						
						* * *						
						* * *						
						* * *						
						* * *	Occupations unknown—Females					
						* * *						
						* * *						
						* * *						
						* * *						
						* * *	All specified occupations—Total					
						* * *						
						* * *						
						* * *						

FORM 43.

Exhibiting, by sex, the number of children under one year of age returned as having died in ——, during the year 18—, distinguishing the months in which they died, their age, in months, at death, the months in which they were born, and whether born in the year of death or in the previous year. Michigan.

Months in which births and deaths occurred.	Number born in each month of year of death.				Number of children that died at each age, in months.											Number born in each month of year previous to year of birth.			Deaths, by months.							
																			Of those born in year of death.			Of those born in previous year.			All aged under 1 year.	
	Year.	Total	Sex.	No. of each sex.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	No. of each sex.	Total.	Year.	Year.	Sex.	Total.	Year.	Sex.	Total.	Sex.	Total.
January	18—		Males... Females.																							
* * * * *	* *		* * *	* *	*	*	*	*	*	*	*	*	*	*	*	* *	* *	* *	* *	* *	* *	* *	* *	* *	* *	* *
Of those born in year of death.	18—		Males... Females.																							
			Total..																							
Of those born in previous year.	18—		Males... Females.																							
			Total..																							
All aged under one year.	18—		Males... Females. Total..																							

Form 44.

The average age of the inhabitants of ——, *of both sexes, of each sex, and the difference between the sexes, for all living June* 1, 18—, *and all returned as having died during the year ending June* 1, 18—, *as compiled from the United States census of that date; for all returned as having died from consumption during the years* 18—, 18—, 18—, 18—; *for all returned as having died from all causes during the years* 18— *to* 18—, *inclusive, as shown by the registration returns; for all living aged twenty and over, as per census June* 1, 18—; *for all aged twenty and over whose ages and occupations were stated in the registration returns of deaths for the years* 18— *to* 18—, *inclusive, and for the native and foreign born inhabitants returned as having died during the years* 18— *and* 18—. *Michigan.*

	Year ending—	Average age, in years and hundredths of a year.			
		Total.	Males.	Females.	Excess, males.
Deaths, as per census					
Living, as per census					
Deaths, as shown by registration returns					
Deaths from consumption, by registration returns					
All living aged 20 and over, per census					
All aged 20 and over whose occupations were stated in registration returns of deaths					
Deaths, as shown by registration returns					
All aged 20 and over whose occupations were stated in registration returns of deaths					
Deaths, as shown by registration returns					
Deaths from consumption, by registration returns					
All aged 20 and over whose occupations were stated in registration returns of deaths					
All who died aged 20 and over, as shown by registration returns					
"Average years of life," after the age of 20 years, plus 20 years, indicate the "average at death" of all who died aged 20 years and over					
Deaths, as shown by registration returns					
Deaths of native-born inhabitants, as shown by registration returns					
Deaths of foreign-born inhabitants, as shown by registration returns					
Deaths from consumption, by registration returns					
All aged 20 and over whose occupations * * *					
All who died aged 20 and over * * *					
Deaths as shown by registration returns					
Deaths of native-born inhabitants * * *					
Deaths of foreign-born inhabitants * * *					
Deaths from consumption * * *					
All aged 20 and over * * *					

FORM 45.

Showing total number of deaths, by color and sex, with population (estimated), for different periods of life, average ages of decedents, the number of widows and widowers, married and single, of and above the age of 20 years, percentages to total mortality, and annual death-rates per 1,000 of each class at different periods of life, for year ending June 30, 18—. District of Columbia.

Color and sex.	All ages.					5 years and over.							* * *					Social relations of, and above twenty years.											
																		Widows and widowers.				Married.				Single.			
	Estimated population.	Total deaths.	Average ages.	Death-rate per 1,000 each class.	Percentage to total mortality.	*	*	*	Percentage to total mortality of each class.	*	*	*						Total deaths.	Average ages.	Percentage to total mortality of each class.	Percentage to total mortality.	*	*	*	*				
White males																													
White females																													
Total white																													
Colored males																													
Colored females																													
Total colored																													
Total white and colored																													

Deaths, showing nativity, duration of residence, and age of white decedents dying of the three diseases specified, and from all other causes, for the year ending June 30, 18—. District of Columbia.

Diseases.	Age of decedent.	District of Columbia.	New England States.				Middle States.				Maryland, West Virginia, and Virginia.				United States not specified.				Ireland.				England, Scotland, and Wales.				Germany.				All other foreign countries.			
			Duration of residence.				* * *																											
			Under 1 year.	1 to 5 years.	5 to 10 years.	10 years and over.																												
Phthisis pulmonalis, or consumption.	Under 5 yrs.																																	
	5 to 10 years.																																	
	10 to 20 years.																																	
	20 to 30 years.																																	
	30 to 40 years.																																	
	40 and over.																																	
Pneumonia																																		
Cancers																																		
All other diseases																																		

FORM 47.

Showing deaths under one year of age, arranged monthly, according to sex and color, with percentages and death-rates, for the year ending June 30, 18—. District of Columbia.

Color and sex.	Ages.				Total.	Percentage to total mortality under 1 year of age by color and sex.
	1 day and under.	1 day to 1 week.	1 week to 1 month.	1 to 2 months. * * *		
July.						
White males						
White females						
Colored males						
Colored females						
Total						

FORM 48.

Showing location in certain sections of deaths and births not occurring in hospitals or similar institutions, with percentages, for the year ending June 30, 18—.
District of Columbia.

Diseases.			City.				County.			
	First division.		First division.		Second division.		First division.		Total deaths.	Percentages.
	Deaths.	Percentages.	Deaths.	Percentages.						
Phthisis pulmonalis										
Pneumonia										
Cholera infantum										
Scarlet fever										
Diphtheria										
Typhoid fevers										
Malarial fevers										
Diarrhœal diseases										
All other diseases										
Total										
Births										

FORM 49.

Showing total deaths and death-rate by color, number of decedents under one year, under 5 years, and 60 years of age and over, together with the principal causes from which these deaths have resulted; also the number of births, marriages, and still-births, stated by months, with rate per 1,000 for each, from ——, 18—, to ——, 18—, inclusive. District of Columbia.

Months.	Total deaths.				No. deaths under 1 year of age.		No. deaths under 5 years of age.		No. deaths 60 years of age and over.		Number of deaths from—													
	White.		Colored.								Measles.		Scarlet fever.		Diphtheria.		Croup.		Whooping-cough.		Typhoid fever.		Cerebro spinal fever.	
	No. of deaths.	Rate per 1,000 white population.	No. of deaths.	Rate per 1,000 colored population.	White.	Colored.	* *	* *	* *	* *	* *	* *												
18—.																								
January																								
February																								
* * *																								
Total deaths 18—.																								

FORM 50.

Showing total deaths and death-rate by color, &c. District of Columbia.

Months.	Number of deaths from—												No. births reported.				No. marriages reported.				Number still-births.			
	Diarrhœal diseases.				Phthisis pulmonalis.		Pneumonia.		Bronchitis.		Diseases of the nervous system.		White.		Colored.		White.		Colored.		* * *		* * *	
	Under 5 years.		All ages.																					
	White.	Colored.	* *	* *									No. of births.	Rate per 1,000 white population.	No. of births.	Rate per 1,000 colored population.	No. of marriages.	Rate per 1,000 persons married white population.	No. of marriages.	* * *	No. of still-births.	Rate per 1,000 white population.	* * *	* * *
January																								
February																								
* * *																								
Total deaths 18—.																								
Grand total																								

APPENDIX P.

CONFERENCE WITH ROYAL COLLEGE OF PHYSICIANS AND SURGEONS, LONDON.

[State Board of Health, Lunacy and Charity, Office of the Chairman of the Health Department.]

COMMONWEALTH OF MASSACHUSETTS,
State House, Boston, December 29, 1880.

DEAR SIR: I have the honor to report that, as one of the committee appointed by the National Board of Health at the conference of statisticians in May, 1880, I conferred with the Royal College of Physicians, committee in London, and that I have had frequent conversations with Dr. George Buchanan, who has actual charge of that portion of the work in which we are most interested.

The committee and Dr. Buchanan know too little, practically, about malaria to enable them to fully deal with that matter; but they consider very favorably the other four recommendations of the committee appointed by your Board. The English committee has adjourned for the present to allow sub-committees time to prepare their work.

Very sincerely and respectfully, yours,

CHARLES F. FOLSOM.

Dr. J. L. CABELL,
President of the National Board of Health.

APPENDIX Q.

QUARANTINE ON THE SOUTHERN COAST.

[Extracts from Report of Dr. HARVEY E. BROWN, U. S. A.]

THE QUESTION OF QUARANTINE.

The joint resolution calls for an opinion "whether any system of quarantine is likely to be effective in preventing invasions of yellow fever." I believe that this question may be unqualifiedly answered in the affirmative, and that the war on quarantine has been partly the result of ignorance of the facts or illogical views of the origin of the disease, and partly because the love of gain, outweighing the natural feelings of humanity, has distorted the unavoidable inconveniences attendant on any quarantine system into a barbarous cruelty, which has come down to us from the Middle Ages, and has no part in the enlightened civilization of the nineteenth century. It is, I think, possible to show that the cruelties and barbarities of quarantine need have no existence under a properly organized system; that its restrictions on commerce have been greatly magnified by those who are interested in the West India traffic; and that the general trade of any city, so far from being injured, would be immensely benefited by a quarantine which would be absolutely protective, such as it is believed it would be possible to institute.

A strong argument in favor of a quarantine may be found in the varying aspects of public opinion at the South. "À la longue, rien ne résiste à l'autorité des faits, et le simple fon sens du vulgaire l'emporte souvent sur les hésitations et les sophismes de l'intérêt et du savoir." It is found that during periods of health the sentiment of the Southern people is strongly opposed to quarantine; but should there be a danger of the approach of the disease it is astonishing what unanimity there is on the subject. The press makes fervent appeals to the boards of health to increase the efficiency of quarantine; leading men, both in and out of the profession, use all their influence to

urge its establishment; and should the disease unfortunately break out the authorities are denounced in the severest manner for their neglect. The medical profession may prove, to their own satisfaction, that the disease is of local origin, but the community does not believe it, and in times of pestilence they see what dreadful losses accrue to them from the prevalence of the disease, and all are quarantinists.

The objections raised against quarantine measures may be either professional, personal, or commercial, and may be summed up as follows:

1. It is urged that inasmuch as yellow fever is a disease of domestic origin in the United States, and due entirely to local causes, or else to the prevalence of what is called an "epidemic atmosphere," a quarantine can by no possibility be of any value in warding off an epidemic.

This objection is best answered by inviting attention again to the facts as set forth in the histories already narrated of the epidemics of yellow fever. These accounts show that in the majority of epidemics of which we have any detailed history its outbreak has been preceded by the arrival of one or more vessels from a port known to be infected; that the first cases are generally either persons who came to port in such vessels or who are known to have been on board of them, and that those next taken sick have had communication with the first; or, if the proof be not so direct as this, it is found that the vicinity of the wharves and docks, and the streets and alleys bordering the harbor are the localities first infected. The earliest cases are in sailor boarding houses, or warehouses where foreign goods are stored, and these cases are in the persons of sailors, stevedores, or workmen about such wharves or warehouses. The filthy condition of such places, always insisted upon as sufficient of itself to produce the disease, does not afford a satisfactory explanation of its existence, because such localities are always the most neglected in a city, and the population such as defy all considerations of personal cleanliness or local hygiene. They are in no worse condition in years of sickness than in those of health, and on the assumption that overcrowded tenements or accumulations of putrefactive *débris* will produce an epidemic, it should prevail in such localities every year, which is not found to be true.

Let it be particularly noted that the conditions productive of fatal disease are in all cases subject to little or no variation, and, therefore, where the causes are perennial, there ought to be no respite from the ravages of deadly maladies. The facts, unfortunately for the theories, are perverse; instead of a confirmation they supply a refutation, to my mind irresistible.—(Pratt on Origin of Fevers, Medical Press and Circular, March 6, 1872, page 206.)

It has already been remarked that the absence of direct evidence of the foreign importation of the disease is no proof that it might not have existed and been overlooked in the difficulty of tracing the previous history of the first victims, who are frequently strangers without friends that are acquainted with their movements before the attack. It is in fact a matter for surprise that we have been able to trace the disease to foreign importation in such a large number of instances rather than that the evidence should be defective in a few.

It is further shown that when the disease leaves the seaboard it has generally followed the great routes of travel or trade. Natchez was not visited by yellow fever before steamboats commenced their trips on the Mississippi River in 1819. After that year the town was ravaged by the disease whenever it prevailed in New Orleans, and never at any other time. Vidalia, La., never suffered previous to 1853, in which year, for the first time, steamboats stopped there. Sabine and Matagorda, in Texas, having only a coastwise commerce, were always exempt until the severity of the blockade at Galveston and the possession of New Orleans by our forces made them convenient resorts for blockade-runners. Houston and the interior towns in Texas have only been visited by the disease subsequent to its appearance on the coast. Many similar instances could be cited.

Moreover, the direct facts in favor of quarantine are equally cogent. New York established a rigid quarantine in 1822, and although the disease has been brought almost yearly to the port it has since that time only twice appeared within the quarantine lines, viz, at Fort Hamilton in 1856, and Governor's Island in 1856 and 1870, both instances being plainly traced to an evasion of the quarantine law. Philadelphia presents a similar record, having been exempt from yellow fever for fifty years, except in 1853, when the bark Mandarin was improperly allowed to pass the quarantine.

In 1798, when almost every seaport town at the North was visited, the authorities at Baltimore established a quarantine and forbade all intercourse with the infected city of Philadelphia, and alone, of all the great commercial cities of the North, escaped, though repeatedly ravaged by epidemics in previous years. From 1840 to 1853 the authorities of Natchez quarantined all steamers arriving from New Orleans during an epidemic season, and in those years they had no fever. In 1853, when they relaxed their quarantine, the disease again made its appearance. In 1862, when the city of Galveston was crowded with the sick and dying, there was not a case among the 10,000 troops in the neighboring forts, all communication between the soldiers and the inhabitants of the town being forbidden by military orders. In 1867 the disease ap-

peared at every town in Texas along the railroads diverging from Houston, except Columbus, Washington, and Richmond. These three places established a quarantine against Houston and Galveston, and they escaped entirely. In 1868 and 1869 the military authorities exercised a supervision over the quarantine along the Texas coast, and there was no appearance of the disease, although it was epidemic at Vera Cruz, Havana, and Key West, and several vessels arrived at the various quarantine stations with cases of fever on board.

These and many other facts which might be adduced go far to show that the favorite theory of an "epidemic constitution of the atmosphere," bidding defiance to all restrictive measures for preventing the entrance of the disease, has no foundation in fact, except as dependent on infection by means of fomites, and an acceptance of the hypothesis of the invariable spread of the disease as a result of the multiplication of its germinal principle (this principle being generally, if not always, an importation in ships, cargoes, or personal property) will afford the strongest possible argument why a properly constituted system of quarantine can be of efficacy, and that the Southern towns can only be rendered free from visitations of yellow fever by such means. Yet it is not to be considered that the value of quarantine depends on the acceptance of any hypothesis of contagion. The actual historical facts are amply sufficient to prove the great service it has been in the past, and to warrant further investigation into the subject with the view of making it more efficient in the future. It can, moreover, be urged with propriety that even if it is granted that some epidemics are not to be explained except by assuming the domestic origin of the disease, yet even then the facts prove that a large number of others are certainly due to importation, and, therefore, by preventing such importation we can materially reduce the number of epidemics, even if we fail in entirely keeping off the disease, which is certainly "a consummation devoutly to be wished."

2. Another objection is, "All epidemic diseases are present in the country, and disorder the health of a people before they are manifested in their peculiar and recognized forms."

This may be true of influenza, and possibly of some of the exanthematious diseases, but it is certainly not the general rule as regards yellow fever. Malarial fevers have often been very common in the spring and early summer, preceding an epidemic of yellow fever (as was the case at Rio Janeiro in 1849); but this coincidence can always be accounted for by local or meteorological causes, and only those who regard the latter as a paludal disease, or a more aggravated form of bilious remittent, would trace any connection between the two. Any one who regards yellow fever as due to a specific poison must reject the idea of such an influence of that poison on the general health as could exhibit itself in an increase of other diseases not allied to it in pathological or etiological phenomena.

Typhoid fever was prevalent at Key West in 1862 before the appearance of the vomito; but it may be presumed this was owing to the presence of an unusually large number of troops, and the great increase in the civil population of the town, from causes resulting from the war. The yellow fever being positively traced to importation by the bark Adventure in the latter part of June, it is simply absurd to suppose any connection between the prevalence of the two diseases.

3. That the experience of the past proves quarantines to be worthless as safeguards against yellow fever.

The instances already cited of its value at New York, Baltimore, Philadelphia, on the coast of Texas, and elsewhere, are a sufficient refutation of this assertion; but as the opponents of quarantine point to particular instances in which it has proved ineffective, it will be proper to examine some of these cases, and ascertain with what justice the charge has been brought. One of these instances may be found in the fact that the legislature of Lousiana established a quarantine in 1821, which was continued until 1825, during which time the city of New Orleans suffered from two severe epidemics, viz, in 1822 and 1824. What are the facts as regards these years? The board of health established a quarantine on the river below New Orleans, but none on Lake Pontchartrain, and in consequence, in August, 1822, two sloops (crowded with persons fleeing from the fever which raged at Pensacola) passed through the lake, and entering the Bayou Saint John, without any inspection, landed their passengers at the basin of the canal Carondelet, in the center of the city. A family by the name of Lynch that arrived on one of these sloops were the first victims and from their residence on Bienville street the fever extended throughout the city. Moreover, the health officer, Dr. Forsythe, reported the quarantine law so defective that there was no restriction placed on intercourse between persons from New Orleans and those detained on infected ships at quarantine, and that vessels were permitted to leave the station and proceed to the city without any proper fumigation. Such are the facts of the epidemic of 1822, and it would be difficult to select an instance which more directly proves the value of a proper quarantine, instead of militating against it; for can any one suppose that if the board of health had used efficient measures in guarding all the avenues of approach to the city there would have been any importation of the disease from Pensacola?

As regards 1824, there is equally positive proof of the utter inefficiency of the health authorities. The disease was introduced by a steam-tug, which had towed the infected schooner Emigrant to the quarantine station. There had been free communication between the tow-boat and the schooner on the passage up the river. Sick men on board the latter were visited by hands employed on the former; yet the schooner alone was detained in quarantine, and the tug proceeded to the city, sending, in a few days, several cases from among her hands to the Charity Hospital with yellow fever.

Commenting on these facts, Carpenter remarks: "In 1821, a mockery in the shape of a quarantine was established, which *in consequence of its total inefficiency* had no effect in preventing the introduction of the disease. It had, moreover, a most pernicious effect in prejudicing many well-intentioned persons against the establishment of such an institution by leading them to regard it as a useless restriction upon trade. The fact is well known that the inadequacy of that institution was solely attributable to the imperfection of the law, *and not to the fallacy of the principle upon which quarantine is based.* (*Op. cit.*, p. 47.)

Of the quarantine in 1867, at New Orleans (which has been repeatedly pointed to as an illustration of the worthlessness of such institutions), Dr. Francis Barnes reports:

"The Florence Peters history illustrates the viciousness of the system of quarantine in operation here, *which does not deserve the name, being a sham, a delusion, a make-believe*, in place of one which would be efficacious if properly carried out. * * * The quarantine here is notoriously a failure in sending any protection to the city, while that of New York is a success." (Circular No. 1, Surgeon-General's Office, 1867, p. 120.)

Assistant Surgeon Samuel Adams, writing of the epidemic at Galveston, Tex., in the same year, says:

The entrance of the disease was entirely the result of gross negligence on the part of the city authorities in failing to take any measures to establish a quarantine for the protection of the city." (*Ibid.*, p. 83.)

A further point in regard to this same epidemic may be mentioned. Of the towns situated in Matagorda Bay, Texas, only one (Matagorda) established a quarantine in 1867. This place escaped entirely, while Indianola, Lavacca, &c., suffered severely.

The prevalence of the fever in the vicinity of the South street wharf in Philadelphia, in 1853, affords testimony of the same character; being unquestionably due, not to the worthlessness of the principles upon which quarantines are established, but to the neglect of the authorities at the lazaretto in permitting the bark Mandarin to come to her dock without proper detention and fumigation. And it may be remarked that this will be found true of every instance where quarantines have been denounced as incompetent to keep out yellow fever; the fault has always been either in a defective law or in a maladministration of its provisions; and it may be positively asserted that in our own country, at least, every absolute quarantine conducted with rigid impartiality has proved successful.

The first quarantine convention held at Philadelphia in 1857, composed of some of the ablest hygienists in the United States, came to the following conclusion, after mature deliberation:

"Efficient sanitary measures, including quarantine, will in most cases prevent the introduction of these (importable) diseases. * * * The present quarantine regulations in operation in most of our States are inefficient and often prejudicial to the interests of the community." (Proceedings, p. 40.)

4. "That quarantine, instead of guarding against and preventing disease, fosters and concentrates it, and places it under conditions the most favorable that can be devised for its general extension."

This objection, made by the general board of health of Great Britain (Report on Quarantine, 1849, p. 61), can only, like the last, apply to a defective administration of a lazaretto. It is hardly to be conceived how it could be true, were ordinary common sense exercised in the management of either infected vessels or persons. Yet, if the account given by the board of the quarantine arrangements at Hull, England, be a fair sample of those in general operation in the United Kingdom, it is not to be wondered at that they arrived at the opinion they express. They state that this quarantine was in Whitebooth Roads, 8 miles from Hull, a locality so stormy as only to be accessible by steamers; that sick and well persons were confined together on board of the detained vessels; and that the quarantine hulk at the roads had no medical officer attached to her. Further, Mr. Robert Hardey, medical superintendent of quarantine at Hull, states that he considered it doubtful whether he had any authority to visit sick persons detained in quarantine; and, although he had been in his official position for seven years, he has "no recollection of receiving either printed or written instructions from the authorities of the customs appertaining to the duties of his office, and does not consider that at present his duties are defined with sufficient clearness."

At another station, at Stangate Creek, the surgeon reported "that his orders were positive and strict not to go on board any vessel in which there was a case of cholera;

that he could not, therefore, on any consideration, go on board such vessel." (Report, pp. 130-138.)

It is no wonder the poor unfortunates, subjected to such inhumanity as this, should denounce quarantine as a relic of barbarism, worthy of the Middle Ages; but that a board of men could only see in such a state of affairs an argument against the principles upon which quarantines are founded is creditable neither to their honesty nor intelligence. There is no reason whatever why a rationally conducted quarantine station should "foster or concentrate disease." Let all persons be removed from an infected ship; the sick to a commodious hospital, the well to a separate building, only to be detained so long as may be requisite for their proper fumigation and disinfection; let all the inhabitants and officials at a quarantine station be acclimated persons, and there need be no cause to fear the extension of the disease. The records of all the well-managed quarantine hospitals in the United States contain ample proof of the truth of this statement. But if even for the sake of argument we assume the possibility of the occurrence, yet I hold that it would be no valid objection to the institution of quarantine. If it comes to a choice between the infection of a lazaretto, containing at most but a hundred or two persons, or the spreading of contagious disease broadcast through a large town, few will be found to question which is the preferable of two evils.

On a par with the foregoing, and of as little importance as a valid argument, is the complaint of the inconveniences to which passengers are subjected by detention at quarantine. No doubt it is extremely unpleasant after a long voyage, and when almost in sight of home, to be refused admission to pratique; but, in the first place, were a uniform system of quarantine in operation throughout the United States, the certainty of such delay would be well understood, and persons would refrain from coming from infected ports during the fever season except in cases of necessity; and, in the second place, it is unreasonable that a large city should jeopardize the lives of thousands of its inhabitants to avoid inconveniencing the few passengers who may arrive from foreign ports. Moreover, leading quarantinists now are of opinion that it is unnecessary to the efficiency of a quarantine that healthy persons should be detained any longer than may be necessary to render it certain that they have not within them the seeds of disease, and to destroy all germs of contagion which might have infected their clothing or baggage. The *point d'appui* of the quarantine of the future is to be the disinfection of the ship and her cargo, and the care of the sick, and the well will be subjected to detention only so long as to insure their safety and avoid the possibility of their infecting the place of their destination.

5. It is further alleged that the difficulty of obtaining accurate information as to the health of the ports of departure is an insuperable obstacle in the way of an efficient quarantine.

This may be granted under the present system, controlled entirely by State or municipal authority; but it would not be true of a quarantine managed by the General Government, which could instruct its foreign consuls in all ports where yellow fever prevails endemically to forward frequent reports of the condition of the places where they are resident. The lines of telegraph now are so widely extended that there would be few towns of any consequence from which a daily report could not be received. Some ports, as Havana and Vera Cruz, may be assumed to be always infected; while others may always be considered as healthy, unless positive evidence to the contrary is received. Every health officer should be required to obtain all the information possible as to the ports from which vessels are likely to arrive, and, aided by the reports obtained from consuls, there is no reason why the most exact knowledge should not be had relative to the health of the whole yellow-fever zone.

6. The last and most important objection to be noticed is that quarantine places unnecessary restrictions on commercial enterprises by interference with the transit of goods by the detention of ships, by the losses of perishable articles, such as fruits, and by the additional expense attendant on increased freightage and insurance charges from delay.

These charges seem very plausible, and require to be examined with some care to expose their fallacy. It is not to be denied that under the present unequal system much inconvenience results to those engaged in foreign trade; but it is believed that many of the present restrictions can be so modified, by a wise law, as to meet the acceptance even of those engaged in the West India traffic. In a subsequent portion of this report occasion will be taken to notice the abuses and defects of the present want of system in the southern quarantines, and to suggest proper remedies; at present I desire merely to show that the charge above mentioned cannot be fairly sustained as a reason why quarantines should be abandoned altogether. The mistake in this case grows out of the assumption that the only persons whose interests are to be considered are those who are, directly or indirectly, engaged in commerce with West Indian or Mexican ports. But this is not a fair view of the question. "Commerce," remarks the distinguished chairman of the New Orleans Chamber of Commerce, "is as much the life of the city merchant as of the ship-owner." The only vessels that need be sub-

jected to delay at quarantine are those coming from West Indian or Mexican ports, and not even all those, but only such as arrive from places where yellow fever is actually prevailing. The business done by these vessels constitutes but a very small portion of the trade of any of the southern towns. Let there be an epidemic in New Orleans, Charleston, or Galveston, and all their immense traffic with the interior is immediately cut off or greatly diminished. Country merchants will not visit the cities to buy goods during the progress of an epidemic, not only on account of the personal danger to themselves, but also because the goods they buy may be infected, and thus the disease be introduced into the country towns. This actually happened at Washington, La., in 1826, at Opelousas in 1828, and at Galveston in 1858.

Moreover, New York and all other places at the North enforce quarantine against the southern sea-ports as soon as yellow fever appears at any of them; and thus the presence of the disease in the latter operates as a restriction on the great trade between the two sections of the country; a matter of far greater importance to the South than the temporary interruption to her West India commerce, which would be caused by an absolute quarantine, conducted on rational principles. Even if such a system had the effect of entirely extinguishing the West India commerce, it would still be a pecuniary gain to the South in the increased trade which would come to her ports from other directions as a result of the feeling of security accruing from the certainty that these places would be kept healthy.

"Should the restrictions on the commerce with the West Indies by quarantine amount to a suspension of the whole trade for six months each year, the evils to the city will be less than it now suffers from the annual apprehension of the fever, and the pecuniary loss of a hundred years by the quarantine establishment cannot equal the ruin and desolation of a single season of pestilence. * * * Is the health of the city to be placed in competition with a few cargoes of sugar and molasses, introduced without care or caution, so as to afford a luxury to our people at the least possible expense of money and at the greatest cost of human life?" (Hume, Report to city council of Charleston, Charleston Medical Journal, vol. 9, pp. 150, 151.)

The editor of this journal further remarks:

"We would recommend a more stringent quarantine system, which would exclude all vessels from infected ports from our harbor. The petty traffic during the summer with the tropical ports usually infected with yellow fever, should not be allowed to continue, as millions of dollars are lost to the city when fever is introduced, and hundreds of lives are wantonly sacrificed. We trust that in future the city authorities will look to the interest of the many, and enforce the quarantine law now in existence, or enact others which may prove efficient." (*Ibid*, vol. 11, p. 850.)

"It is admitted that much inconvenience would result to the mercantile community from the strict enforcement of the aforesaid measure (of quarantine), but it is believed that the loss of property in the aggregate would be much greater if our citizens shall be compelled annually to flee from the pestilence than would result from a system of strict quarantine duly observed and rigidly enforced." (Dr. A. F. Vaché, Letters to committee of house of assembly of New York, November 5, 1845.)

Vexatious and inconvenient as quarantines may be, yet even under the worst circumstances their restraints fall upon a very small portion of any community, and those the ones best able to bear them. An epidemic of yellow fever affects all classes and conditions. It brings desolation into every household, paralyzes trade, stops immigration, and causes an enormous waste of money and the material resources which go to make up the prosperity of any city. Especially in its present condition the South needs men, yet those who would add to its material prosperity will not go where they cannot have a permanent residence for themselves and their families but are obliged to leave every summer to escape the pestilence. It may safely be asserted that the southern cities would soon double their population were it not for the dread which universally exists of these epidemics of yellow fever. Replace this feeling by one of security, such as will be given by a well-regulated quarantine, and the unequaled advantages which the southern sea-port towns offer for commercial enterprises of every kind will attract the capital and labor which more than anything else they require. The public mind is not disposed to theorize on such questions. "It demands protection against the importation of infectious disease, and will not sanction the abolition of quarantine inspections." The moral effect of an efficient quarantine on the community at large outweighs in its importance all the inconveniences resulting from the restrictions placed on a portion of the southern trade; and when to this is added, as it justly may be, its absolute protective influence, the objections made to its continuance will not for a moment stand the ordeal of investigation. The whole argument may be summed up in the following words of wisdom from the pen of Prof. John T. Metcalfe: "To abandon quarantine is to put a price on human life and barter it for trade." (Essays of the United States Sanitary Commission, p. 272.)

The last inquiry made by the joint resolution is, "What system will least interfere with the interests of commerce of said ports?"

Having already given my opinion that quarantine can be made an effective protec-

tion against the invasions of yellow fever, and that under a wise administration of its provision it need not interfere to any great extent with the commercial prosperity of the southern ports, and having shown in the preceding pages that the quarantines under the present State and municipal regulations are not to be depended upon to accomplish the desired end, it follows that some other system must be looked to to secure immunity from epidemics.

On this point the opinions of those with whom I had an opportunity of conversing was nearly unanimous that only under the direction and control of the general government can any reasonable degree of protection be afforded, conjoined with such competency of administration as will afford the largest liberty to the interests of trade consistent with public safety.

The board of heath of the city of Pensacola state that "this board does earnestly solicit that Congress may take such further action upon the subject as shall place the whole matter of quarantine under the exclusive jurisdiction and control of the authorities of the United States."

Dr. Jerome Cochran, health officer of the city of Mobile, writes: "I am thoroughly satisfied that a quarantine under the control of the general government would be far more efficient than any other plan that can be adopted. We need a complete sanitary cordon all along the Atlantic coast, and especially all along the coast of the Gulf of Mexico, and this will be very difficult under the action of the various State and municipal governments. The fever poison follows the lines of commercial intercourse, and the power which regulates commerce should be extended also to the regulation of quarantine." (Letter, September 28, 1872.)

Prof. J. T. Gilmore, of Mobile, writes: "Believing that the yellow fever can be imported, I of course am an advocate of efficient quarantine, and I am satisified that this cannot be done except by the federal government. Local and private interests always so vitiate the efficiency of a local quarantine that it is rendered useless." (Letter, September 10, 1872.)

Mr. J. H. Oglesby, president of the New Orleans Chamber of Commerce, is of opinion that "the laws imposing quarantine from foreign infected ports ought to be uniform throughout the United States. In giving expression to this opinion it is not necessary to discuss the extent of power legally to be exercised by the federal government. It is sufficient to know that the power to regulate commerce enables Congress to impose a uniform tax on all commodities imported, and so prevent one city from intercepting the commerce of another by an offer of more favorable duties on such imports. The effects of the quarantine system as adopted by the several States enables one city to cut off all communication with another, except under certain conditions fatal to the trade. Congress should, therefore, organize an appropriate bureau of public health. With the chief of this department should be reposed the power to make, at his discretion, proclamation of the existence of infectious or epidemic diseases at any foreign port, and thereupon to declare such foreign port interdicted (except on conditions defined by law) with all ports within the jurisdiction of the United States, and to make such interdiction at his discretion. The health authorities at all such American ports should be appointed or approved by the bureau of public health. The salaries of all such officers and employés so appointed, with all other expenses properly attending the enforcement of the law, should be paid out of the federal Treasury, and in no other manner. * * * The federal government can better preserve the general health *and protect the general commerce* than can be done by the competitions or even combinations of rival cities." (Letter, July 20, 1872.)

APPENDIX R.

SANITARY WORK IN NEW ORLEANS.

BY DR. S. M. BEMISS.

SIR: I respectfully offer the following report of my official action as member of the National Board of Health, on duty in the city of New Orleans:

GULF COAST.

For the purpose of organizing a system of service and of sanitary measures designed to protect the Gulf coast of Mississippi, in aid of the State and county authorities, I made, during the month of April, visits to Pearlington, Bay Saint Louis, Pass Christian, Biloxi, and Pascagoula. At the latter place there is a small but well-equipped hospital, with a very efficient system of quarantine. This port is located in Jackson County, and is under the jurisdiction of the State board of Mississippi. By some accident of legislation the bill which constituted the present State board of Mississippi failed to include the counties of Hancock and Harrison, both bordering on the Gulf. I therefore considered it a necessary measure to appoint a sanitary inspector at each of the exposed ports of these counties, in accordance with the request of the proper local authorities of said counties.

After obtaining proper authority from the executive committee, I appointed Dr. J. A. Mead at Pearlington, Dr. E. Latham at Bay Saint Louis, Dr. C. E. Le Roux at Pass Christian, and Dr. A. P. Champlin at Biloxi. These gentlemen were not placed on duty until the last of July. Their instructions were:

1. To keep a constant watch for "outside" vessels arriving at their respective ports, and to order them back to Ship Island if sickness of a suspicious character was found on board, or if a reasonable suspicion of infection existed.

2. They were instructed to board all coastwise craft arriving from suspected places, or places at which yellow fever was reported to exist. In addition to this, they were to hold themselves in readiness to board and inspect trains passing through their respective towns, if circumstances of danger rendered such service necessary.

3. Each one of these inspectors was instructed to make contingent arrangements for the proper and safe care of yellow-fever patients, should any cases occur in their respective towns or be taken off cars or ships, by securing an isolated house and an acclimated nurse to take charge of them. This was done in each instance without expense to the board, since it happily occurred that it was not found necessary to make use of the provision secured. I must be permitted to express my belief that this latter arrangement is one of such manifest importance that every town exposed to incursions of yellow fever should place itself in this state of prudent preparation. These instructions, setting forth the conditions under which the aid solicited would be given by the National Board, were adopted and ordered to be enforced by the proper local authorities.

It is gratifying to report that all the health authorities of the Gulf coast east of the mouth of the Mississippi River have acted in full accord with the National Board of Health in the measures recommended by the Board for the execution and enforcement of their regulations to prevent the introduction and dissemination of infectious diseases.

SHIP ISLAND QUARANTINE STATION.

When the Board determined to construct a quarantine station on Ship Island, the general superintendence of the design was placed in my hands. The immediate inspection and approval of contract, and of the work done by the contractor, was intrusted to Capt. W. H. Heuer, of the Engineer Corp of the United States Army, who consented to assume this responsibility. The Board is under obligations for the energy and skill manifested by Captain Heuer in the supervision of these works.

The buildings at Ship Island are temporary, in the sense of being constructed of cheap materials and at small expense, but they are strongly built and are admirably designed for the purposes they are intended to subserve. I know of only two further items of expenditure necessary to render its equipment complete. These are, first, some suitable appliances for burning sulphur in holds or apartments of vessels, as well as in the disinfecting-room at the warehouse; second, floating-ballast sufficient to answer the purposes of at least three ships.

I did not think it expedient to suggest to the executive committee that a code of instructions should be published for the government of masters and pilots of ships until the wharf was completed and full assurance could be given that every possible facility and guarantee of safety could accompany the order. Therefore no such instructions have been published, and the official or other statements to the effect that ships have been required to go a "day's sail out of their way" are erroneous. Shortly after the organization of the State board of Louisiana I addressed a communication to its president, Dr. Joseph Jones, which, together with his reply and the opinion of the attorney-general of the State, with the correspondence to which it gave rise, are as follows:

NEW ORLEANS LA., *April* 10, 1880.

SIR: I wish respectfully to lay before the State board the following points of information regarding the Ship Island quarantine.

The precise rules and regulations for the government of Ship Island quarantine will not be promulgated until the meeting of the National Board of Health on the 2d of May. They will not vary essentially from the following schedule of main points:

1st. The intentions of the station at Ship Island are (*a*) to diminish the danger of importation of infectious and epidemic diseases by detaining and disinfecting infected vessels at a distance sufficiently remote from the coast to prevent communication of disease from those quarantined; (*b*) to provide for passengers and crews of infected vessels good hospital accommodations and treatment for the sick, and comfortable and well-isolated accommodations for the well, who may be detained for observation; (*c*) to provide suitable warehouses for stowing cargo while vessels are being cleaned, and suitable disinfecting-rooms and appliances in order that goods, clothing, &c., shall be disinfected promptly and thoroughly.

2d. Vessels which will be required to stop at Ship Island quarantine station are (*a*) those which actually have infectious diseases among their passengers or crew; (*b*) those which have had such diseases on board during the voyage or their stay in a foreign port; (*c*) those which sail from ports dangerously infected with epidemic diseases or touch at such ports; (*d*) those vessels which may be required by the quarantine regulations of Louisiana, Mississippi, or Alabama to stop at Ship Island station.

3d. Vessels not included in the above enumerated classes are not required to stop at Ship Island; does not supersede or in any manner interfere with any State regulations now in force or hereafter to be enforced.

4th. It is not to deprive local boards of health of any revenues or pecuniary profits which would otherwise accrue to them.

5th. The quarantine station at Ship Island is intended to be entirely co-operative with those sanitary organizations engaged in the same important work of protecting our people from pestilential diseases, and their concurrence and co-operation are absolute necessities to its success. Therefore, as the member of the National Board of Health to whose supervision this work is intrusted, I respectfully ask an immediate reply to the following inquiries:

1st. Will the State board of health co-operate with the National Board in enforcing such rules for the government of Ship Island quarantine as do not conflict with the above schedule?

2d. Will the State board of health order vessels back to Ship Island which attempt to come to this port in contravention to these rules, except under any peculiar circumstances where the State board and the undersigned acting for the National Board might concur in opinion that it was safe and proper to direct otherwise?

3d. Will the State board order its quarantine inspectors to accept bills of health and certificates of disinfection from the chief medical officer at Ship Island, and not subject vessels provided with them to further quarantine restrictions?

SAMUEL M. BEMISS,
Member National Board of Health.

Prof. JOSEPH JONES,
President State Board of Health.

OFFICE OF THE BOARD OF HEALTH, STATE OF LOUISIANA,
New Orleans, April 22, 1880.

SIR: In reply to your communication of April 10, relating to the Ship Island quarantine, I beg leave respectfully to submit the following:

On the 12th instant, on motion of Mr. J. N. Marks, the board empower-

dent to refer the communication of the member of the National Board of Health to the attorney-general of the State of Louisiana, with the request that his legal opinion be furnished at the earliest practical moment.

The reply of the attorney-general, J. C. Egan, was received on the 22d instant, and laid before the board of health at its meeting in the evening of the same date, at 7½ o'clock p. m.

Upon reading the report, Mr. J. N. Marks offered the following resolution:

"Whereas Dr. Bemiss of the National Board of Health, in a communication addressed to this board, propounded certain interrogatories growing out of the proposed national quarantine at Ship Island;

"And whereas the said communication was referred to the attorney-general of the State in order to ascertain how far this board possessed the legal power to carry out the desires of the National Board;

"And whereas the attorney-general holds the opinion that this board cannot delegate its power, and must therefore, under the laws of this State, perform its own functions:

"*Be it therefore resolved*, That the president of this board be, and is hereby, requested to reply to the communication of Dr. Bemiss, conveying to him in substance the opinion of the attorney-general."

In accordance with this resolution I herewith inclose the following copy of the letter of the attorney-general.

Respectfully, your obedient servant,

JOSEPH JONES, M. D.,
President Board of Health State of Louisiana.

Prof. S. M. BEMISS, M. D.,
Member National Board of Health, New Orleans, La.

ATTORNEY-GENERAL'S OFFICE, STATE OF LOUISIANA,
New Orleans, La., *April* 22, 1880.

DEAR SIR: Your communication referring to me the letter of the National Board of Health has been received. I consider that for the purposes of quarantine it would be in the power of your board to order ships coming to this port back to Ship Island as a condition to their entry, if in your opinion such a measure would tend to the better security of this State from infectious diseases. But as there is no absolute requirement, and as quarantine is in restraint of free commerce, it is, in my opinion, within the discretion of the board to adopt such prudential measures as will protect the State from the importation of disease, and which will the most lightly affect the trade of our port.

While the law confides largely in the discretion of the board, I think the trust reposed was not intended to be delegated, and no matter how high the character of the National Board may be, I think the law contemplates the personal service of the State board in the prevention of pestilence.

I am of opinion, therefore, that bills of health and certificates of disinfection from the chief medical officer at Ship Island should not be conclusively satisfactory to the State board of health.

It is useless for me to advise your board to a spirit of the fullest and most cordial co-operation with the National Board of Health compatible with your views of a sound system of prevention of epidemic disease.

Very respectfully,

J. C. EGAN, *Attorney-General.*

Dr. JOSEPH JONES,
President Board of Health.

MAY 10, 1880.

DEAR SIR: I am directed by the National Board of Health to acknowledge the receipt of your communication of April 22, addressed to Dr. S. Bemiss, the representative of the board in New Orleans, and transmitting an opinion of the attorney-general of the State on certain questions relative to the quarantine to be established under the auspices of the National Board at Ship Island in aid of the State and municipal authorities in preventing the introduction of contagious and infectious diseases into the Gulf ports.

I am instructed to say that this Board is much gratified and obliged by your polite note and by the tenor of the opinion of the attorney-general, which has been read with attention and entire concurrence in its conclusions. No specific practical conclusion is announced in your communication, but this Board understands that, while the State board of health of Louisiana does not intend to, and does not in fact, delegate any one of the powers intrusted to it by law, and will not hold any bill of health or certificate of disinfection from the chief medical officer at Ship Island "conclu-

sively satisfactory" to the State authorities, they will, nevertheless, order *infected* ships cruising to the port of New Orleans back to the quarantine station established by the National Board at Ship Island as a condition to their entry into that port.

I am, very respectfully and truly, yours,

J. L. CABELL,
President National Board of Health.

Dr. JOSEPH JONES,
President State Board of Health of Louisiana, New Orleans, La.

OFFICE BOARD OF HEALTH, STATE OF LOUISIANA,
New Orleans, La., May 17, 1880.

SIR: In reply to the communication of the president of the National Board of Health of the 10th instant, relating to Ship Island quarantine, the State board of health, at the last regular meeting, on the 13th instant, held that there was nothing in the official communication to the National Board of Health which warranted the assertion that "they will order infected ships coming to the port of New Orleans back to the quarantine station established by the National Board of Health at Ship Island, as a condition of the entry into that port."

Inclosed please find copy of the resolution offered by Mr. Marks on the 22d of April.

The board of health of the State of Louisiana cannot delegate its quarantine powers to any other organization, whether created by Congress or by individual States.

Respectfully, your obedient servant,

JOSEPH JONES, M. D.,
President Board of Health

J. L. CABELL, M. D.,
President National Board of Health, Washington, D. C.

The method pursued for disinfecting vessels at Ship Island is set forth in Dr. Martin's report, as follows:

NATIONAL BOARD OF HEALTH,
New Orleans, November 23, 1880.

SIR: In accordance with your verbal request of November 12, 1880, I have the honor to submit the following report of treatment of vessels which arrived at the national quarantine station, Ship Island, Miss., from April 26, 1880, to October 18, 1880.

Immediately on arrival all vessels were subjected to a thorough inspection and examination of holds, bilges, cabins, store-rooms, officers' and men's quarters; the officers and crew mustered and personally examined. If found in a healthy condition and the vessel from a non-infected port, she was permitted to proceed to her destination.

Vessels arriving from infected ports were required to discharge as much ballast as possible without jeopardizing the safety of the vessel; that portion which was retained as stiffening was shifted from one part of hold to another; the hold was then washed and scrubbed down with hickory brooms; in some cases part of it was scraped; parts of the flooring, fore, aft, and amidships, was taken up, so that the space or packing between the two skins of the hull might be thoroughly examined and cleaned; the store, junk-rooms, officers' and men's quarters were broken out, also washed, scraped, holy-stoned, dunnage thrown overboard, and on vessels on which fever had occurred officers' quarters were painted;* the vessel was then fumigated by burning sulphur in iron pots from twelve to sixteen hours, making vessel air-tight as possible during the process; the amount of sulphur consumed varying according to the size of the vessel. The largest quantity was 150 pounds, the smallest 80 pounds. The hold was then washed with a solution of copperas, then whitewashed. The bilges were pumped out daily until they were found sweet and clean, when a saturated solution of copperas was applied. The bedding was washed and repicked, and all the woolen clothing of the men scrubbed and washed in hot water, and aired daily.

Due credit was given all vessels arriving with certificates from agents of National Board of Health.

All captains were instructed about keeping their vessels in a cleanly condition, and the benefit to be derived therefrom in event of sailing from infected ports.

I am pleased to state that, notwithstanding the fact that several vessels arrived on which infectious diseases had occurred at port of departure, no cases developed after their release.

Very respectfully, your obedient servant,

WM. MARTIN, M. D.

Dr. S. M. BEMISS,
Member National Board of Health, New Orleans, La.

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* Officers' quarters were painted after fumigation.

I recommend that on the approach of the hot season of 1881, when the Board shall promulgate instructions to owners, agents, and masters of ships coming to Ship Island station for treatment, that it shall be carefully specified what fees, if any, shall be charged, and for what consideration. Hitherto only the cost of disinfectants used has been exacted, and these sums, aggregating near $150, have been turned over to the sub-treasury here and receipts forwarded to the honorable Secretary of the Treasury.

MISSISSIPPI QUARANTINE STATION.

This station, as guarding the principal avenue by which yellow fever has been so often introduced into New Orleans and other places in the Mississippi Valley, is justly regarded as the most important one in the United States in its relations to the public health.

Without now adverting to its probable faulty location, attention should be called to the fact that ships given free pratique with ballast yet on board have been allowed to come to the city and discharge ballast upon the wharves.

FEVER ON LOWER COAST.

On the 4th of September I met a gentleman who informed me that Dr. J. C. Wilkinson, the oldest and most experienced physician on the lower coast, had advised him and others to take their unacclimated children out of the neighborhood on account of cases of yellow fever in a family by the name of Giordam residing near them.

I immediately addressed letters to the president of the State board and to Drs. Wilkinson and Hays, requesting information in regard to these rumors.

Dr. Wilkinson replied, confirming the report made to me, that he had advised persons to take children unacclimated to yellow fever out of the neighborhood in order to secure them from attacks of that disease. Dr. Hays differed from Dr. Wilkinson in diagnosis, and pronounced the fever malarial in character.

My subsequent action in this matter is set forth in the following documents:

NEW ORLEANS, *September* 5, 1880.

SIR: At half-past two o'clock on yesterday (Saturday) afternoon Prof. Ernest Lewis brought into my office a gentleman who informed me that a very fatal form of fever was prevailing in the parish of Plaquemines, at or near Point Michel. This gentleman stated that he had given you this information about eleven o'clock Friday morning. I now respectfully ask that you give me at the earliest moment practicable such information as you may have received concerning this reported outbreak of serious disease.

This request is made in the interest of public health and welfare, not only that I may exercise my influence, and, if necessary, the money at my command in arresting the further spread of infectious disease, but also that I may aid in preventing unnecessary quarantine against this State or city.

Respectfully,

S. M. BEMISS.

JOS. JONES, M. D.,
President State Board of Health, Louisiana.

BOARD OF HEALTH, STATE OF LOUISIANA.
New Orleans, September 5, 1880.

SIR: In reply to your communication of this instant, I have to state that telegrams have been addressed to the officers of the board of health and to prominent physicians at Mississippi quarantine stations, Port Eads, Point à la Hache, and other places, not only asking information as to the truth of the rumor to which you allude, but also directing a special inspection and the institution of any sanitary precautions, should any be deemed necessary, as was reported to the board of health of the State of Louisiana. Thus far I have received a reply from Dr. Wilkinson, jr., whose father is said to have attended two cases of fever on the right bank, about fifty-two miles below this city, which gave rise to the rumor. Dr. Wilkinson knows nothing of the cases.

I have just received the following telegram from Dr. B. N. Taylor, who has your order to investigate the cases in person:

"PORT EADS, *September* 5, 1880.

"DR. JOSEPH JONES, M. D., *President Board of Health*:

"I have reason to believe that there is not a particle of truth in the reports. Malarial fever in exceedingly mild form exists around and near the Passes and all along that coast. Will visit the family and report at the earliest date.

"B. N. TAYLOR, M. D.,
"Sanitary Inspector."

Respectfully,

JOSEPH JONES, M. D.,
President Board of Health.

S. M. BEMISS, M. D.,
Member National Board of Health.

NEW ORLEANS, LA., *September* 13, 1880.

SIR: I respectfully call your attention to the accompanying report from Dr. G. M. Sternberg, regarding the disease at this time prevailing on the lower coast of the Mississippi River. In my opinion the symptoms and mode of spread bear so close a resemblance to yellow fever that no time should be lost in applying all possible means to prevent its further spread. With a view to the accomplishment of this end, I have to inform you that you are authorized to draw upon the National Board of Health for such sums of money as may be necessary to procure disinfectants and to pay for the services of sanitary police and sanitary inspectors, and in truth all expenses expedient to the purposes mentioned. This money cannot be drawn from the Treasury except in payment of bills for services or articles, which bills must be duly authenticated. You will therefore make requisitions from time to time for such service, disinfectants, &c., as are in your opinion required, and forward same to me. This appropriation will apply to cases of infectious diseases in this city, and in all places within the limits of the State which have no local boards to exercise such powers. The organization of the work will rest with yourself, subject to the approval of the National Board. You will therefore in all cases forward me the names of persons recommended to be employed, with pay of each, and each one must take an oath of office, and have his name carefully entered upon blank pay-rolls which will be furnished you, and then no trouble will occur in regard to payments. It is well to remark that the Treasury Department refuses to pay for goods or clothing destroyed to prevent spread of disease, but will pay any reasonable expenses for cleaning and disinfectants.

S. M. BEMISS.

Dr. JOSEPH JONES,
President Louisiana State Board of Health.

BOARD OF HEALTH, STATE OF LOUISIANA,
New Orleans, September 13, 1880.

SIR: The communication of the member of the National Board of Health of this date has been received and its contents noted.

The board of health of the State of Louisiana has investigated the malarial fever to which you refer as prevailing in the low rice lands bordering on the Mississippi River above and below Point Michel.

Such measures as the board of health deem necessary have been instituted.

Respectfully,

JOSEPH JONES, M. D.

Prof. S. M. BEMISS, M. D.,
Member National Board of Health, New Orleans, Louisiana.

REPORT OF DR. GEORGE M. STERNBERG, U. S. A.

NEW ORLEANS, LA., *September* 10, 1880.

SIR: I have the honor to report that, in compliance with your request, I have visited Point Michel and Point à la Hache, for the purpose of ascertaining the nature of the sickness prevailing there. Dr. Hays, in whose practice most of the cases have occurred, aided me in every manner possible, and in his company and that of Dr. Taylor, who represents the State board of health, I visited about twenty cases of the prevailing fever. Many of Dr. Hays's patients are convalescent, but in the practice of Dr. Heber, on the opposite side of the river, I found three recent cases in one house and three in another, distant five miles from the first. In one of these houses we also found the dead body of Andrew Dragou, a light mulatto, aged seventeen, who died about two hours before our arrival. Dr. Hays has had in his practice sixty-one cases, and Dr. Heber, so far as I could learn, seven cases of the prevailing fever. The first case occurred August 15, in the practice of Dr. Hays, on the right bank of the river, seven miles below his house.

The following day a case occurred two miles above the first. On the 20th (August) another case occurred in the vicinity of the first, and one within two miles of Dr. Hays's house. On the 22d two cases; on the 23d two cases; and on the 24th two cases were taken sick in the neighborhood of the first case; on the 24th three cases also occurred in a locality one and one-quarter miles above the doctor's house. This was followed by three on the 25th and three on the 26th in the same locality. Dr. Hays was also called to see a case on the opposite side of the river, four miles below his house, on the 23d. In the locality one and one-fourth miles above Dr. Hays's house four children have died in the family of —— Girdeau. The two remaining children in the family had been seriously sick, but at the time of my visit appeared

to be convalescent. A young man named Little, aged nineteen, also died in this vicinity making six deaths in all, on both sides of the river, in a total of sixty-eight cases. It is not my intention at present to study this local epidemic from an etiological point of view. I desire simply to state the facts as I was able to glean in a single day which have a bearing upon the question of diagnosis. While abundant rains fell during the month of August above and below this vicinity, I am informed that for a month, until quite recently, there was no rain in this immediate neighborhood; also, that a disagreeable odor was observed to come from *batture* along the river bank. Rice is cultivated extensively in the vicinity, and one or two of the cases were taken sick while at work in the rice-fields. I would observe here, however, that nearly all of the cases are young children, and that the adults who, by reason of their exposure in the rice-fields, would be most subject to malarial poisoning, have to a great extent escaped. The cases have mostly been children of French creoles—light mulattoes—who constitute the greater portion of the population in this vicinity. I inquired as to whether any of the cases had previously suffered from yellow fever, but could not get any very definite information. A similar fever prevailed in 1878, which some physicians called yellow fever, but Dr. Hays believes it also to have been malarial fever. The area in which this fever prevailed on the right bank of the river was somewhat different from that in which most of the cases have occurred this year. The fever of 1878 did not extend below a certain point, while the fever of this year has been mostly below this line. As to the nature of the disease, it is a continued fever of a single paroxysm, lasting, it is said, from a few hours to four or five days. No regular temperature observations have been made, but from the statements of Dr. Hays, and my own observations, I am satisfied that the fever is of a mild grade, and not characterized by remissions or intermissions. The highest temperature observed by me was 103½° (second day of disease). At the outset of the attack the eyes are glistening, pupils more or less dilated, gums bright red and swollen, tongue slightly or heavily coated with a white fur, in some cases almost clean, and in one dry and brownish. The skin is usually moist and perspiring. In two cases I noticed that the excitement caused by our presence caused the perspiration to cease and the skin to become dry. Pulse rather soft and not very frequent (in two cases, second day, in which I counted, it was 100). Slight pain in head and loins at commencement of attack. Afterward no pain was complained of, except occasionally some epigastric distress. There was bilious vomiting at the outset in some of these cases. In others no vomiting occurred. In only one of the fatal cases (child of Girdeau) was there a suspicion of coffee-ground vomit. One or two had nose-bleed at the commencement of the attack. No other hemorrhages are reported. Dr. Hays had not discovered any albumen in the urine of his fatal cases. In Dr. Heber's fatal case the urine was highly albuminous, and suppression occurred sixteen hours before death. The depending portions of the body of this young man presented a mottled appearance two hours after death. His natural color was light yellow. I did not discover any decided yellowness of the conjunctivæ in any case. Yellowness of the skin I could hardly have distinguished, on account of the complexion of the patient. I found albumen in three cases. Other cases in which no albumen was found were too far advanced in convalescence or too early in the disease to make the absence of albumen a point of diagnostic importance. In one case, in which the most abundant deposit of albumen occurred—a boy of 12—the boy was dressed and sitting up. He had slight fever, glistening eyes, red, spongy gums, and slight headache.

Finally, as to the diagnosis, I believe these cases to correspond with what is known in the Antilles and tropical America as *fièvre inflammatoire, fièvre d'acclimation, fièvre jaune bénigne, fièvre jaune abortive, fièvre jaune des creoles, dengue*, &c. Bérenger-Feraud says of these fevers: "These fevers may exist sporadically, like the yellow fever, and also epidemically, *but it is above all at the approach or decline of the epidemics of yellow fever that they are observed in the greatest number*. They present different forms; the most frequent form is observed among peoples *who are subject to be attacked by yellow fever*. It offers all the symptomatic appearances of the first degree of yellow fever, coloration of the skin and eyes, elevation of temperature and pulse, cephalalgia, rachialgia, contusive pains in the limbs. But whatever may be the intensity of these symptoms they all disappear at the end of twenty-four or forty-eight hours, and recovery takes place." In 1875 Bérenger-Feraud lost but three cases in 400, and in 1876 one case in 216. Such is the resemblance of this form of fever with the first degree of yellow fever that when it is observed sporadically without an epidemic of yellow fever the doctors of the country say, "If we were in the time of yellow fever we would say that it is yellow fever." Bérenger-Feraud claims that this fever prevails everywhere that yellow fever reigns, and says, "It is a disease very near if not identical with yellow fever—an incomplete yellow fever." For me this fever is identical with yellow fever, and only differs in degree from the more severe forms which, because of the fatality which attends them, are known and dreaded by all. It seems to me extremely unscientific to make our diagnosis depend upon a greater or less percentage of mortality, and the sooner physicians in the yellow-fever zone admit, what I believe to be true,

that yellow fever is not always a malignant disease, and that the immunity of creoles is due to their having suffered (generally in childhood) from this milder form of the disease which has received so many different names, and that it is not a birthright, the better it will be for the progress of medical science and the true interests of the countries where these diseases prevail.

GEO. M. STERNBERG,
Surgeon, U. S. A.

SECOND REPORT OF DR. GEORGE M. STERNBERG, U. S. A., MEMBER COMMISSION VISITING POINT À LA HACHE AND VICINITY.

I regret to say that I can find no good reason for changing the opinion, given after my first visit to Point Michel, as to the nature of the fever prevailing in that vicinity. I have not seen during either visit any case which, *alone*, would enable me to make a positive diagnosis of yellow fever, but from a consideration of all the cases seen by me during my two visits, and of the facts relating to the origin and progress of the epidemic, cannot doubt that this fever is the mild type of yellow fever which has been described under various synonyms given in my previous report, and which Blair more properly calls "yellow fever *simplex*" to distinguish it from the more malignant type called by him "*gravior*." The main facts upon which I base this opinion are the following: The first cases, so far as I can learn, occurred in the practice of Dr. Westerfield directly opposite the quarantine station, about the 1st of August. It will be remembered that the infected bark Excelsior was anchored at this point for eleven days, from June 24 to July 5. No cases occurred in Dr. Westerfield's practice for four or five days after the first case, when six cases occurred in one family, 1¼ miles below, then seven cases in another family, about the middle of August. It was about this time (August 15) that Dr. Hays saw his first case, 7 miles down the river from his house. This locality subsequently furnished a considerable number of cases (at least fifteen). Later (August 24) an infected locality was developed 1¼ miles above Dr. Hays's house; up to this time no deaths had occurred, but in this locality four children died in one family, and a young man in the immediate neighborhood still later. September 4 the fatal case of Adrain Dragon and other mild cases in the same family occurred in the practice of Dr. Hébert, on the east bank of the river, and several miles farther upstream.

In the practice of Dr. Wilkinson, on the west bank of the river, and just above Dr. Hays's, no cases of the same fever have occurred. Dr. Westerfield says that his cases occurred mostly where there is a batture on the river front; where there was no batture he had no cases. He says the disease has taken the same course as in 1878. He does not recollect that one of the cases of this year had fever in 1878. The majority were French children. Has had some severe cases, with great irritability of stomach, but no deaths. Did not examine the urine or make temperature observations. The theory that this fever results from malarial emanations from rice-fields seems to me untenable from the history of this epidemic, as above given, from the fact that adults are most exposed to these emanations, while children are most subject to this fever, and that in various localities where rice is cultivated, as in Dr. Wilkinson's practice, this fever has not prevailed. I am informed that a similar fever does prevail at Port Eads, where there are no rice-fields. There is, however, in this vicinity, a pilot's village and a custom-house station, so that it is presumable that communication with infected vessels occurs before these vessels are subjected to disinfection, &c. I am also informed that communication between this point and the city of New Orleans is unrestricted. At the quarantine station I find a little settlement of two or three houses within a few hundred yards of the wharf, over which the quarantine physician has no control. The facilities for intercourse with infected vessels are certainly not insurmountable, and I find, moreover, that river packets which touch all along the banks of the river on their way up and down from New Orleans are in the habit of tying up for the night at the quarantine wharf. There is, therefore, no difficulty in accounting for the introduction and dissemination of a disease such as I suppose this to be, and from my point of view the battures along the river bank furnish favorable local conditions for the increase of the specific poison of the disease during the summer months.

As to the clinical history, I have no reason to believe that all the cases of fever on the river banks have been of the same nature. Drs. Wilkinson, Hébert, and Hays all state that cases of intermittent fever constantly occur in their practice, and doubtless autumnal remittents prevail to some extent. Temperature observations have only been made in a few cases, but the history given me by Dr. Hays and Dr. Hébert of the cases which I have seen is of a continued fever of a single paroxysm, lasting from twenty-four hours to four or five days. I have obtained an incomplete record of temperature in two cases only. Tommy Gilmore, aged ten, was taken sick at *midnight* Sunday (September 12); no chill; temperature, 106°; Monday morning temperature,

105°; evening, 104°.5; Tuesday morning, 104°; Wednesday, 3 p. m., 103°; Thursday morning, 101°.6. I was unable to obtain a specimen of urine for examination in this case. Michael Halcum, aged 25 (?), says he had yellow fever in 1867; taken sick at 10 a. m. Sunday (September 12); temperature Sunday noon, 103°; Monday morning, 101°.8+; evening, 102°.2+; Wednesday morning, 101°. Has albuminous urine, highly acid, and containing granular tube casts. In one case in the practice of Dr. Jones a relapse occurred from exposure before complete convalescence was established. We found this patient, a boy of twelve, very much prostrated, and having highly albuminous urine of acid reaction, containing granular tube casts. This is the fifth case in which I have found albumen in the urine, and that in a fever which is chiefly characterized by the mildness of its course and the absence of distressing symptoms—a very different fever, in my view, from the high grade of malarial fever, with a tendency to local congestion and hemorrhages, which occasionally presents the phenomenon of albuminous urine. In one case, in the stages of calm, the patient had a pulse of 60 beats in the minute. I should say, from my observations, that this fever is characterized by rather a slow (after the first day) and soft pulse, a perspiring skin, a clear intellect, and an irritable stomach. I did not observe yellowness of the skin or conjunctivæ in any case; but do not look upon this symptom as a common characteristic of the milder form of yellow fever. My experience in regard to this point corresponds with that of Blair, who says: "It certainly must be admitted that a large proportion of the cases of yellow fever are unattended by yellowness of the surface, or even of the eye, for the disease may be cut short by treatment (?), or the epidemic may be of the simplex grade, or the mitior, and the yellow suffusion may be so slight as to escape notice." The total number of cases has been about 100, exclusive of those occurring in the practice of Dr. Westerfield, whose figures I did not obtain.

The temperature-chart in the case of Dr. Wilkinson, jr., as given by Dr. Finney, certainly justifies a diagnosis of remittent fever; but, as already stated, the history given by Dr. Hays and Dr. Hébert, both upon my first and second visit, was of a continued fever. Dr. Wilkinson, sr., the most experienced practitioner in the vicinity, who has been called to see many of the severe cases in consultation, made an unqualified diagnosis of yellow fever. He is perfectly familiar with malarial fevers of the country, and has seen much of yellow fever; has had cases of malarial fever in his practice this fall, but considers the severe cases of continued fever which he has seen in the practice of Drs. Hébert and Hays as undoubted cases of yellow fever. Dr. Hébert evidently is much inclined to agree with Dr. Wilkinson. Dr. Hays insists that the disease is a malarial fever *of the same type as he saw in* 1878, which some practitioners in the vicinity called at the time yellow fever, but which he has never admitted to have been yellow fever.

Respectfully submitted.

GEORGE M. STERNBERG,
Surgeon, U. S. A.

THE RICE FEVER.

Reports of Doctors Bruns and Davidson on the fever which prevailed in Plaquemines Parish

No. 142 Canal Street, New Orleans,
September 18, 1880.

Dear Sir: In obedience to your request of the 14th of September, that I should "proceed to the lower coast of the Mississippi River to inspect and report in regard to the prevalence of any infectious or other forms of fever prevailing in that section of the State," I have the honor to report that, on the morning of the 15th, at 8 a. m., the committee, consisting of Dr. J. P. Davidson, of the State board of health; Dr. G. M. Sternberg, surgeon United States Army, and myself, with Dr. Mitchell, of the National Board, who kindly accompanied us, and my son, Mr. H. D. Bruns, who volunteered to make the necessary autopsies, if opportunity offered, proceeded on the steam-tug Aspinwall directly to Myrtle Grove, the plantation of Dr. J. B. Wilkinson, the oldest and most experienced physician in the parish of Plaquemines. We there learned that the doctor had been called to visit a case of fever on the left bank of the river, seven miles below, in consultation with the resident physician, Dr. N. M. Hébert. We reached the place designated, five miles above Point à la Hache, too late to meet Dr. Wilkinson, but had the good fortune to encounter Dr. Hébert, who, with great courtesy, at once invited us to see his patient, a typical case, as he regarded it, of the prevailing fever. The following was his account of the case:

Paul Gravolet, white, male, aged twenty-two years, had sat up for two nights with Adrian Dragou, sick of the fever, and had afterward attended his funeral. It was the body of this A. Dragou which Dr. Sternberg had seen on his previous visit to the parish and noticed in his report. A short while after, on the afternoon of the 10th, Gravolet was taken with a chill, followed by a violent headache, pain in the loins and legs, nausea, retching, and fever. Dr. Hébert visited him for the first time on the 12th instant, at 8 a. m., and found him suffering from fever, with a hot, dry skin; temper-

ature not noted. The vomiting of bile and mucus continued; the eyes were congested; the tongue moist, streaked in center, red at tip and edges, and was covered with a white fur; the fur had disappeared on the fourth day, leaving the whole organ red; the gums were red and swollen, but firm; there was much restlessness throughout the attack; the respiration was tranquil, without sighing; he complained of slight pain on pressure over epigastrium; the urine had been abundant, and free from albumen; there had been no delirium; comp. cath. pills, followed on Monday by calc. magnes., had acted freely, and quinine, in 4-grain doses, until 52 grains were taken—in forty-eight hours—had been ordered, after the action of the magnesia. The doctor could not say that he had noticed any decided remission at the period of his visits, morning and evening, but had sometimes found him perspiring. He had broken his thermometer and could not tell what the diurnal variations of temperature may have been.

At the time of our visit, 1.30 p. m., September 15, the pulse was 80 to the minute, temperature 101¼° Fahr., respiration normal, tongue clean, gums pink and firm, skin pleasantly warm and soft, presenting no harshness nor pungency to the touch; the face was flushed, without capillary congestion; the body was of the natural color, and neither it nor the eyes showed the least tinge of yellowness; the *facies* was perfectly calm and the patient cheerful. He complained of some pain on pressure over stomach and abdomen. At 11 a. m. he had passed a small quantity of bright, florid blood by stool. The urine was abundant. A fresh specimen, tested on the spot, yielded, on the addition of nitric acid, a light precipitate, which cleared up perfectly on boiling. At our second visit, a little after noon the following day, we found him still convalescing. He had passed a little bright blood by stool during the night, but had slept well. The pulse was 60 to the minute, temperature 99⅗° Fahr. No albumen in urine.

In the same neighborhood we saw, with Dr. Hébert, Pierre Dragou, white, male, aged five years, the younger brother of the above-mentioned Adrian. Three days before our visit he had recovered from an attack of fever; but two days after convalescence had partaken freely of sardines and chicken for breakfast, and at noon was seized with violent vomiting and purging. There had been no hemorrhage from bowels. The child was calm and cheerful; the skin soft and moist; the temperature carefully taken in axilla was 106° Fahr. The pulse of the little patient, much excited by our presence, was by first count 110 to the minute. At the close of our somewhat protracted visit, it had fallen to 92. There had been six cases of fever in this family. All had recovered but Adrian. A small specimen of the patient's urine, very dirty, full of hairs and mucus, was secured. It threw down a flaky deposit on the addition of nitric acid, not cleared by boiling. As a substitute for filtering paper, a single thickness of newspaper was tried. I thought it a clear case of failure, but, if trustworthy, the urine contained a trace of albumen. At our visit in the afternoon of the following day the patient was convalescent, though still somewhat feverish.

Another patient of Dr. Hébert's visited by us in this neighborhood was Eliza Martin, white, female, aged fourteen years. She had come from New Orleans on the afternoon of the 10th, and was taken with fever three days after. She had been treated with calomel and quinine. On the second day of her fever (Tuesday), Dr. Hébert reports a well-remarked remission in the morning. When seen by us on Wednesday at 3 p. m. her pulse was 120 to the minute; temperature, 103⅗° Fahr.; the tongue soft, moist, marked by the teeth, covered with light white fur; the gums pale, pink, firm; *facies* calm; skin pleasant to touch and bedewed with slight perspiration. There was a tendency to diarrhœa, and slight pain was complained of on pressure over abdomen. Urine, tested on the spot with nitric acid and heat, was free from albumen.

On the opposite side of the river, at the Franklin Rice Mill, we also visited with Dr. Hébert a patient of Dr. Hays's, Michael Halceran, a native of Louisiana, white, male, married, aged thirty-three years. He had been taken on the 12th at 10 a. m. with chill, violent headache, and pain in back and legs, accompanied by gastric distress and vomiting. The last continued throughout his attack, but we learned from his friends, and from his physician later, that this gastric irritability characterized him even in health. He is a confirmed dyspeptic, vomits his food frequently, and is unable to retain a dose of medicine unless it be disguised and concealed even from his suspicion. Dr. Hays informed us the next day that when he first saw Halceran, at 12 m. on Sunday, two hours after his seizure, the temperature was 103° Fahr. Of his temperature Monday he had no record, and did not recall it, but on Tuesday he found it to be 101⅘° Fahr. at his morning visit, and 102¼° Fahr. in the afternoon. He was said to have had yellow fever during the epidemic of 1867.

At the time of our visit, we found him perfectly free of fever. He conversed cheerfully and readily, and his whole appearance was indicative of rapid and fine convalescence. The temperature was 100° Fahr., pulse 62 to the minute, full, soft, slow; tongue clean and moist; no yellowness of conjunctiva or skin. Auscultation of heart revealed a soft, aortic, systolic murmur. Further inquiry, afterward confirmed by Dr. Hays, revealed the fact that the patient had suffered from more than one attack of

acute rheumatic fever. The urine showed a small quantity of albumen, probably persistent.

In an adjacent town I saw Mrs. Halceran, wife of above, well advanced in convalescence from a similar attack of fever, lasting only forty-eight hours. She complained of feeling a little weak, but had a good appetite, which she had been indulging for some days freely and without harm. Though we touched at this point the following day, we did not think it worth while to visit these patients again.

Moving down the right bank of the river we stopped at Dr. George B. Hays's residence, Point Michel, and were immediately joined by the doctor, who came on board the tug, and took us to visit some of the more interesting cases of his own, then under treatment. The great majority of the patients he has had were well or convalescent.

William Gilmore, white, male, aged nine years, was taken at midnight Sunday with the usual light chill and pains in back and legs. Dr. Hays, at the date of his first visit, about noon on Monday, found him with high fever, hot, dry skin, frequent, quick pulse, white furred tongue, and free from nausea or pain at epigastrium; the respiration was slightly hurried, without sighing, and there was no jactitation. His temperature was 106° Fahr. The following forenoon it was 105° Fahr.; in the afternoon $104\frac{1}{4}$° Fahr. On Wednesday morning it was $104\frac{1}{4}$° Fahr. At the time of our visit, 5.20 p. m., it was 103° Fahr. Although an unusually nervous child and ministered to by a still more nervous mother, who hastened to inform him that the visit of so many doctors did not necessarily portend immediate dissolution, his expression was placid, exhibiting neither alarm or depression. The conjunctivæ were pinkish; but there was no intolerance of light, nor pain on pressure over the eyeballs. The face was slightly flushed without capillary congestion. The color of the body was natural, and there was no yellowness of skin or eyes. To the touch the surface was dry and warm, without harshness or pungency. The pulse was 100 to the minute; respiration normal, no suspiria. The bowels had been freely moved; the dejections were natural, the urine copious. There was slight uneasiness manifested on pressure over epigastrium, and headache; but he made no complaint except of slight headache.

The following day we visited him again at 10 a. m. He had slept well; had two rather thin stools during night, the last at 4 a. m.; with both had passed urine freely. The pulse was 92; temperature, $101\frac{3}{5}$° Fahr. *Facies* cheerful, skin pleasant. From the excessive nervousness of the little patient, we could not secure a specimen of urine for examination at either visit.

In this locality we also visited, with Dr. Hays, Millaudon Potoon, black, male, aged fourteen years, who was said to have had a relapse, succeeding a fever of four days' duration. We saw him again the following morning. At neither visit did he have any fever. The skin was rather cool, temperature normal, pulse soft and very compressible, but not frequent. The appetite was feeble, strength much exhausted, mind spiritless and dejected. He answered questions willingly but slowly, and without animation. The decubitus was lateral, with the legs semiflexed, and we found him lying in exactly the same position, with the same air of utter indifference, on our second visit as we had left him on our first. He made no complaint, and on repeated inquiry admitted no special discomfort. His mother told us that he had been at work in the fields up to the date of his first attack; but the very great emaciation he exhibited was certainly not attributable to the brief acute attack he had experienced. He looked to me to be like a well-advanced case of tuberculosis, and on inquiry I learned from Dr. Hays that his father had died of phthisis pulmonalis. Dr. Hays had never examined his chest, and his condition and surroundings were such as not to invite my personal auscultation of him. A specimen of his urine exhibited, on the usual tests, an abundance of albumen.

In the same room lay a younger brother of Millaudon, convalescent from a mild attack of the fever.

At the quarantine station, which we reached at 9 p. m., we found to our regret the assistant quarantine physician, Dr. C. P. Wilkinson, down with the fever. He had been taken with the usual symptoms of chill, headache, pain in the back and legs, at 6 a. m. on Sunday, the 12th, and when visited by us on Wednesday at 10 p. m. was, therefore, within eight hours of completing his fourth day. The quarantine physician, Dr. Finney, had kept an accurate record of his temperature—the sole instance in which we had the fortune to obtain it—from which it appeared that, on seizure, his temperature was $100\frac{1}{4}$° Fahr. At noon the same day it was 103°, and the same in the evening.

	Temp. Fahr. °.
Monday morning	101
Monday afternoon	104
Tuesday morning	101
Tuesday afternoon	104
Wednesday morning	101
Wednesday afternoon	104
And at 10 p. m., as taken by myself	103

He had, when we saw him, a hot skin; broad moist tongue, covered with white fur; pulse 90, full, soft, regular, no precordial nor abdominal distress nor vomiting throughout the attack. He had taken quinine in 10-grain doses three times on day of attack, but, owing to the irritation it excited, had at first moderated and then discontinued its use. Wednesday he had taken two 3-grain doses. He talked to us with unusual animation and energy that night, and the following morning when we visited him, a little after daybreak, we found him perfectly free from fever, in high spirits, and only anxious to resume as soon as possible the duties which he has performed with so much zeal, fidelity, and intelligence.

Dr. Wilkinson is a native of Lousiana, aged thirty years. He stated that he had had an attack of yellow fever, in common with other members of his family, in 1855.

At an early hour the following morning, September 16, we crossed the river to Buras's post-office, which lies immediately opposite the quarantine station. There we had the pleasure of meeting with Dr. Westerfield, whose practice extends for many miles above and below that point. The sum of the information gathered from him was to the effect that the fever had prevailed very extensively in that neighborhood —principally above—which he attributed to the batture, there being a caving bank, washed by the river below. The fever had made its first appearance early in August, and about ten days thereafter had spread through the entire settlement, as many as five, six, and seven cases occurring in single families, and in some of these death by yellow fever had happened in 1878. The majority of his cases had been among white children. Negroes enjoyed, seemingly, more immunity, and females still greater. The average duration of the fever was about forty-eight hours, he thought. It yielded readily to quinine; fevers chiefly of the remittent type, though he had seen a few intermittents. There had been no death in his practice, nor had he seen a single case in which there was jaundice, black vomit, or suppression of urine.

Dr. Jones, whose area of observation and practice lies on the same bank of the river, between that of Dr. Westerfield and that of Dr. Hays, and with whom we passed some time later in the day, had treated about thirteen cases in all. There was, he thought, a well-marked remission in every case he had seen, but he had made no thermometric observations. The exacerbation took place toward night. The fever yielded readily to quinine, which he gave freely. The only difficulties he had experienced in the management of his cases arose from the tendency to undue cerebral excitement in children. He had lost none, nor had he seen any case with jaundice, black vomit, or suppression of urine.

Dr. Ryan told Dr. Davidson that at Pilot Town the same fever had prevailed extensively. He regarded it as a malarial fever, remittent in type. It yielded readily to quinine. He had no death in his practice, nor had any of his cases been attended with yellowness of skin or eyes, or black vomit, or suppression of urine.

Visiting, with Drs. Hays, Hébert, and Jones, who joined us, such cases of special interest as we had seen on the previous day, we reached Myrtle Groove about 2 p. m., and after an interesting conversation with Dr. J. B. Wilkinson—who, with two of his sons, paid us a visit on the tug—steamed directly for the city, which we reached at 6 p. m. on Thursday evening.

Through your own forethought and Dr. Mitchell's attentions we enjoyed every comfort possible on such a trip, and I take this opportunity, on the part of the whole commission, to express their deep sense of the courtesy they received from all the medical practitioners of the coast, who, with equal candor and cordiality at much self-sacrifice, devoted a large part of the two days to showing us every case of interest in their practice and giving us all the information that could possibly throw any light on the object of our mission.

From personal observation, and from the information gathered on the spot, I have no hesitation in expressing, with the utmost confidence, the conviction that the disease now and lately prevailing on the lower coast is an endemic malarial fever of remittent type, and for the most part of a mild character. Its unusual prevalence is due partly to the meteorological conditions of the past summer, and partly, I believe, to the widely increased cultivation of rice. The alarm it temporarily excited was owing to its fatal results in a single family at the outset. Beyond this isolated instance it has been attended with the slightest mortality, and but for that it would have scarcely excited comment except as to its prevalence and diffusion. The diagnosis obviously lies between malarial and yellow fever, and the reasons for assigning it to the former class seem to me patent and indisputable.

In the first place, all the practitioners in the infected district agree in the opinion, unqualifiedly expressed, that the disease is remittent fever, such as they are accustomed to treat every summer. The laity seem generally to share their views, giving the fever the trivial names, indifferently, of *la fievre du pays* or *la fievre paludienne*. Its ready amenability to quinine is, in itself, a strong proof of its miasmatic nature. If accurate records had been kept, they would have been of prime assistance in arriving at certain conclusions; but, owing to loss or breakage of instruments, Dr. Hays was the only physician we met possessed of a thermometer, and the infrequency of his visits, from the great number of patients and the distances to be traveled, lessened the

value of his observations as a clinical aid to diagnosis. Nor was it possible, from the most painstaking inquiry, to extract any supplemental information from the attendants or families of the sick. For the most part untrained, ignorant, careless, incapable alike of observing or describing the most familiar phenomena, the utmost that could be hoped from them as nurses would be to give a dose of medicine at prescribed hours. Under these circumstances the general impression of the medical attendant as to the continued or interrupted course of the fever is the only evidence that can be had, and this, as I have stated, was uniformly to the effect that in all the cases diurnal remissions occurred, usually in the morning, judging from lowered pulses, diminished heat of skin, moisture, &c.

In theory and in text-books a remission is a well-defined, notable abatement, at calculable intervals, of all the more prominent symptoms of the fever, lasting for many hours. But at the bedside, especially in our graver forms of autumnal fevers, a remission is too frequently an obscure, imperfect, and ill-defined pause, as it were, between two prolonged exacerbations, filling up almost twice the entire round of twenty-four hours. The temporarily lowered pulse swiftly resumes its force and frequency; the moisture, slight and transient, extending only over the forehead, face, and neck, quickly dries up, and the accurate and continued observation which marks the brief return of the same phenomena at the same hour of the succeeding day can alone truly interpret its quality and meaning.

With their imperfect opportunities and means of detecting such remissions it is scarcely to be wondered at that the physicians had no charts to exhibit. But Dr. Wilkinson was suffering when we saw him from the same time of fever that we had seen in him all day, and in his case the record kept by Dr. Finney supplies the missing link. It shows an access of fever, lasting all Sunday, with a well-marked remission in the morning and exacerbation in the evening of the following day, and the exact repetition of this rise and fall of temperature on two successive days thereafter, terminating at the end of the fourth day in a complete apyrexia.

Had a similar record been kept in all the cases I do not doubt that it would have equally exhibited their remitting character, though doubtless in many of them the remissions may not have been so strongly marked.

So much concerning the type. Of the nature of the fever, without multiplying details, I will simply say that neither in its special features nor in their entirety could I realize a single prominent characteristic of yellow fever.

The broad, white, lightly-furred tongue, moist in all stages, lacking the dry, brown center or fiery tip and edges; the firm gums, free from sordes or oozing, or the clear or only lightly-suffused eye, not smoky or brilliant or dull, with no tinge of yellowness; the warm, pleasant skin, neither bathed in hot sweat, nor harsh, nor pungent to the touch, nor bronzed, nor jaundiced, nor exhibiting capillary congestion; the universal freedom from jactitation and delirium; the normal respiration, neither hurried, nor labored, nor sighing; the *facies*, free alike from terror or depression, calm, cheerful, smiling; the notable absence of any stage of calm intervening between a primary or secondary fever or of black vomit, or tarry dejection, or suppression of the urine, or sudden cardiac syncope, render it as certain as clinical observation can that the fever is not yellow fever.

And if we except the Giordano family, the extremely light mortality is no new important factor in the conclusion. Dr. Hays attributes the death of these four children of one household to their intractableness and refusal to take medicine. Now, in the graver forms of malarial fever the early and free administration of quinine often offers the sole means of saving life; but I cannot help thinking that, in this instance, there coexisted some peculiarly malign local influence not made out, or special family predisposition not understood—a fact we are called on frequently to deplore. For of at least 150 cases that we can reckon, and doubtless a large number of others among the negroes, who neither sought nor obtained medical assistance, scattered along both banks of the river, under bad hygienic conditions, crowded in close, damp, dark, ill-ventilated rooms, seen usually late and necessarily infrequently, with no nursing, or worse, lifted out of bed or seated up for every occasion, in every stage of the disease, and fed or starved as fortune favored—improperly and unseasonably often, and as the waking or the whim of the nurse chanced; out of this large number of cases, as we have said, but two deaths have occurred. Yellow fever, whenever it prevails—so far as I know—stands high among the most fatal diseases of our nosological table.

Nor is there any hint of such a march of the disease from house to house, or by personal contact, as can almost always be traced in contagious diseases breaking out among a sparse population, and never so easily traced as under such conditions as exist here, when the dwelling-houses are stretched along in one continuous and unbroken line, following the curves of the levee under which they lie.

What are the facts? Dr. Westerfield told us that his first cases occurred early in August, and by the 10th, after a pause of a few days, the whole settlement was involved. Dr. Hays gives a somewhat similar history of his section; but his first case did not occur until the 15th of August. Now, the middle of Dr. Westerfield's line is directly opposite the quarantine station. Dr. Hays's practice lies many miles above.

And at first sight this might seem to furnish a clue to the source of the disease, if it were yellow fever, although we knew of but one infected ship, the Excelsior, at quarantine this summer, though of course many ships from infected ports have been detained there from time to time. The solution of the phenomenon, granting the disease to be malarial, is not far to seek. Owing to the shorter distance to the Gulf, and the natural configuration of the land, drainage in the lower is much more rapid than that in the upper part of this area. Mr. F. C. Brooks, a planter of the neighborhood, informs me that, although the rice matures in both sections about the same time, the difference in the time of drainage (the water being let off the fields simultaneously) is from seven to ten days, nearly. As the water is left off usually about the middle of July, the fever, as might have been anticipated, made its appearance along the river from below upward just so soon as the hot sun of July and August could draw up from the reeking ground the miasm which, whatever its specific nature, is doubtless telluric in its origin.

Finally, the epidemic now prevailing in the parish of Plaquemines is, unhappily, not confined to the lower coast. Along both banks of the river as far up as Donaldsonville, in Jefferson, in Saint John Baptist, Saint Charles, Saint James, and Ascension, I am informed by my friends—physicians and planters—that the same or a similar fever exists. Since the latter part of June I have treated in New Orleans a fever identical with that which I found in Plaquemines, invariably remittent, and many of them far more serious than any which I saw below. A few days only before I started on this mission I had treated for a severe remittent the clerk of the Alvin, a packet in the lower coast trade. He was seized with the fever on the coast, and brought to the city with it.

And this wide-spread outbreak of malaria, during the present summer, is generally attributed by the residents along the river, above and below, to the increased acreage under cultivation in rice. In a letter from Dr. E. Duffel, of Ascension, dated September 13, and received on my return, that most competent observer says: "I am very busy, having a great many cases of malarial fevers, at times very fatal, particularly if neglected at first. One of the worst complications is congestion of the brain, and few, if any, recover when thus affected. The extensive cultivation of rice in Louisiana will be very detrimental to the health of the people and a scourge."

A planter on the lower coast tells me that eight or nine years ago malarial fevers were comparatively infrequent and mild in that section, but have increased in numbers and severity just in proportion to the increase of the rice area. I do not doubt the truth of the statement, which is in strict accordance with all we know of the history of rice culture and its connection with miasmatic fevers elsewhere, notably in South Carolina and Georgia. In Louisiana two potent causes will contribute to the increased cultivation of this cereal. The poor man will give a natural preference to a crop which can be raised with small expenditure of labor, and which needs no capital to take it off, and the wealthier sugar-planter finds in it a valuable accessory to his main crop, harvested early, commanding cash readily, and furnishing, at the very season he most needs it, the large outlay required to convert his standing cane into a marketable commodity.

Whether the health of New Orleans will thus be engendered only time can show, but that our hitherto salubrious lowlands, if turned into paddy fields, will become hotbeds of malaria, hostile to the health and perhaps fatal to the presence of the white race, there is little reason to doubt.

I have the honor to be, very respectfully, your obedient servant,

J. DICKSON BRUNS, M. D.,
Chairman Committee on Fever of Lower Coast.

I concur with the above full and able report regarding the disease prevailing on the Lower Mississippi coast as essentially a miasmatic fever of a remittent type, occasioned by the emanations from the rice fields stretched along the coast, and its diffusion over so extended an area as probably due to the peculiarities of the present season, characterized, as it has been, by long-continued rains, followed at harvest time of the rice by very hot and dry weather. I saw no case of the fever which, in my judgment, could be said to present diagnostic signs of yellow fever.

J. P. DAVIDSON, M. D.

S. M. BEMISS, M. D.,
Resident Member National Board of Health.

The report of Drs. Bruns and Davidson was made the rule for my official action, as the following telegram will show:

NEW ORLEANS, *September* 22.

TURNER, *Secretary, Washington, D. C.:*

Commission appointed by National Board of Health reports fever on Lower Mississippi to be malarial.

This may be given Associated Press. Reports will be published in New Orleans papers.

BEMISS.

To some it may not seem clearly justifiable for a sanitarian occupying the responsible position which I held at the time of these occurrences to surrender honest convictions in the discharge of official duties. But, while the circumstances were particularly embarrassing, it appeared to me at the time to be my duty to adopt the majority report as a rule of action.

But it so happened that one of the children in a family warned by Dr. Wilkinson to leave the neighborhood came to the environs of the city and there was attacked with yellow fever on the day after its arrival, and died on the third day.

This case is referred to in the following telegram from the acting president of the Louisiana State board of health:

[Telegram from Dr. F. Loeber, acting president of the Louisiana State board of health.]

NEW ORLEANS, LA., *October* 5, 1880.

Dr. T. J. TURNER, *Secretary National Board of Health, Washington, D. C.:*

One death from yellow fever on the night of September 4, at No. 409 South Liberty street, nearly a mile from the commercial centers, and the same distance from the harbor. Immediate burial, disinfection of premises have been enforced, and all precautions will be taken.

F. LOEBER,
Acting President State Board of Health.

The Amoretti family, disappointed in their efforts to escape the pestilence, concluded to return to their home, which was done a few days after the child's death, taking with them the Giordani child.

Some time after their arrival at home a third child (of Amoretti) took sick and died like the brother in a few hours and with same symptoms. About October 5 the Giordani child, which had accompanied them in their flight and returned with them, fell ill and died of same trouble, being the fifth child which died in Giordani's family of same disease.

RELATIONS WITH STATE BOARD OF LOUISIANA.

Soon after the organization of the State board I had an interview with its president, and assured him of a disposition on the part of the National Board of Health to co-operate with the State board, and tendered him all the information and aid we were able to afford him as presiding officer of his board. Similar assurances were made in an official meeting of the joint conference committee of the "Auxiliary Sanitary Association," the "Cotton Exchange" of New Orleans, the State board, and myself as representative of the National Board.

At a subsequent date, June —, 1880, sanitary inspectors nominated by the president of the State board of health of Louisiana were appointed by the National Board. These officers, who were to be paid by the National Board, were charged with the duty of inspecting all river craft and railroad freight leaving the city. It was at first proposed to confine these inspections to river craft, but the president of the State board represented that it was equally important to make inspections of railroad freight, and that both were essential to give confidence to other communities. In accordance with his request, the railroad inspections were ordered to be made by the officers in question, who had been nominated by himself.

During the night of the 5th of July the bark Excelsior arrived at the wharf at the foot of Calliope street. On the evening of the 7th, forty-three hours after her arrival, one of her sailors was attacked with yellow fever. The local sanitary authorities were in entire ignorance of the existence of this case of fever until the patient was taken to Touro Infirmary, on the 10th of July. The patient there fell under the charge of Dr. Loeber, a member of the State board of health, who recognized the nature of the disease, and promptly reported it to his board.

The Excelsior was freighted with coffee, which was landed before the case of fever was discovered among her crew. Prior also to this time some several hundred sacks of the coffee had been shipped to various places in the West and South. I looked upon it as my duty to give information to the sanitary authorities at the places to which these shipments had been made. A good deal of unnecessary and excited discussion arose in consequence of the action of the National Board in relation to the Excelsior's cargo. The action has been fully explained in the quarterly report of the Board for the quarter ending September 30, 1880.

I am entirely unable to state what number of cases of yellow fever have occurred in Louisiana or New Orleans whose origin may with great probability be attributed to infection introduced by the Excelsior. Excluding from consideration the cases which occurred on the lower coast not very distant from the quarantine station, I am certain that a case of yellow fever occurred somewhere about the first week of August,

and within a radius of four squares from the Excelsior's landing. Shortly subsequent to this period I was credibly informed that a case of yellow fever had been treated by a highly respectable physician, and the diagnosis had been verified by one of the most experienced practitioners of the city.

On the 4th of October a death occurred from yellow fever at No. 409 Liberty street. In this instance also the source of infection is unknown.

A gentleman concerned in shipping interests informed Inspector S. H. Collins that he was the owner of a house in the immediate rear of the house 409 Liberty street, and that the captain of the Excelsior had remained there while his vessel was detained in quarantine, but refused more circumstantial information upon finding that Dr. Collins was in the service of the National Board.

With such scanty information as I was able to obtain it was difficult to determine whether my line of duty did not require me to advise close quarantine against New Orleans by surrounding States and populations. In my ultimate determination to adopt a different course, I was greatly influenced by two considerations:

1st. That the vigilance of the officers during inspection service would aid in protecting other communities from importation of infections from New Orleans.

2d. The cases which occurred showed feeble epidemic force or tendency to spread.

I cannot close this report without a favorable mention of the fact that Mr. Clarke, the vice-president of the Chicago, Saint Louis and New Orleans Railroad, in the early part of the summer requested me to appoint a medical inspector for constant service on his line of road. With the consent of the executive committee, I appointed Dr. Henry Stone, who, by the request of Mr. Clarke, was to receive his pay from the road, but his instructions from the National Board.

Mr. Pandelly, the manager of Morgan's Louisiana and Texas Railroad and line of ships, also adopted this plan, and I appointed Dr. Paul Carrington as medical inspector for their lines, by approval of the executive committee. This method is worthy of more general adoption.

Respectfully submitted.

S. M. BEMISS, M. D.,
Member National Board of Health.

Dr. J. L. CABELL,
President of the National Board of Health.

APPENDIX S.

MISSISSIPPI RIVER INSPECTION SERVICE.

BY DR. R. W. MITCHELL.

MEMPHIS, TENN., *December* 31, 1880.

SIR: Pursuant to instructions dated May 15, 1880, I was placed in charge of the Mississippi River inspection service, and directed to locate and put in operation the several stations forthwith, and to organize the service in all its details in accordance with the plans and estimates previously submitted and approved by the executive committee. Dr. F. W. Reilly was ordered to report for duty as my assistant, and I empowered him to select inspectors for the various stations, officers, engineers, and other employés for the patrol boat and launches (then being built at Pittsburgh, Pa.), and all other persons necessary for the conduct of the service, subject to the approval of the executive committee of the National Board.

On the 25th of May inspections were begun at the port of New Orleans, the stations below Vicksburg, Mississippi, and Memphis having been meanwhile established, with Inspectors Banks and Collins in charge, respectively. June 23 an additional station, in charge of Inspector Ashton, was established at Bayou Sara, La., at the request of the Shreveport (La.) board of health and of the steamboat interests concerned in the navigation of the Red, Ouachita, and Atchafalaya Rivers. The establishment of the Cairo (Ill.) station was deferred (pending the receipt of the necessary request from the local health authorities) until July 14, when it also was opened, in charge of Inspector Smith.

Inspections were continued at New Orleans and Vicksburg until October 15, an extension beyond the time originally contemplated (September 30), made necessary by the action of the Vicksburg authorities, who, in view of the sickness in Plaquemines Parish, Louisiana, below New Orleans, and for other reasons, made on September 24 a formal request that inspections of boats clearing from New Orleans for Vicksburg be continued until October 15.

The station at Cairo was suspended provisionally on August 21, primarily because of the absence of suspicious sickness in the valley above New Orleans, and incidentally because the expense of maintaining the additional station at Bayou Sara had not been estimated for, and its maintenance, which was deemed important, had trenched upon the sum at the disposal of the inspection service.

PERSONNEL OF THE SERVICE.

The following-named persons were employed as river inspectors during the season:

Ashton, Dr. W. W.—Appointed inspector in charge, Bayou Sara station, June 12: transferred to reserve corps October 7.

Banks, Dr. E.—Appointed inspector in charge Vicksburg Station May 24; resigned August 23.

Collins, Inspector S. H.—Relieved from special duty in Memphis and ordered to Memphis station as inspector in charge May 21; transferred to New Orleans August 2; made supervising inspector at that port August 7, *vice* Rice, relieved; transferred to Ship Island quarantine station October 16.

Kennedy, Dr. S. D.—Appointed inspector at New Orleans August 1; transferred to reserve corps September 30.

McCutchon, Inspector P. B.—Transferred from reserve corps and assigned to duty at New Orleans May 25; transferred to reserve corps October 16.

Parham, Inspector F. W.—Transferred from reserve corps and assigned to duty at New Orleans May 25; ordered to Memphis station to relieve Inspector Collins July 31; transferred to reserve corps October 1.

Rice, Inspector C. A.—Transferred from reserve corps and assigned to duty as supervising inspector at the port of New Orleans June 2; relieved at his own request and ordered to Cairo Station to relieve Inspector Smith August 7; ordered to Vicksburg Station to relieve Inspector Banks August 21; transferred to reserve corps October 31.

Smith, Dr. W. R.—Appointed inspector in charge of Cairo Station July 14; resigned August 11.

The remaining *personnel* of the service comprised the officers and crew of the patrol-boat, H. H. Benner—a captain, pilot, mate, engineer, purser, carpenter, cook, watchman, two firemen, and three deck-hands; also, two engineers and two firemen for the steam-launches Lookout and Sentinel:* one boatman at the Cairo Station; two boatmen and a cook at each of the stations at Memphis and Vicksburg; and one boatman and a watchman at the Bayou Sara Station—making a total of eight inspectors and twenty-six employés.

While the director cordially acknowledges the intelligent and faithful support he has received from the inspectors generally, there is much to be desired in the methods of securing the proper officers for this service. During the prevalence of an epidemic it is usually easy to obtain the best professional services; but when the ordinary current goes on uninterruptedly it requires special inducements to cause medical men to abandon practice and isolate themselves from family, home, and society in the monotonous and irksome conduct of an inspection station. It will probably always be feasible to fill positions at large cities like New Orleans; but it can hardly be expected that the Board will meet with the same good fortune in the future that it has during the past season in satisfactorily officering the intermediate stations. These are, of necessity, unattractive positions; remote from companionship and not seldom unhealthy by reason of malarious surroundings.† When to this is added the limited duration of the season and rate of pay allowed, it will be seen that the service offers few inducements to properly qualified men.

THE NATURE OF THE INSPECTIONS, AND THEIR EFFECT UPON THE COMMERCE OF THE MISSISSIPPI VALLEY.

In anticipation of closing the stations on the 30th September, a circular-letter was addressed to the inspectors in charge on the 18th of that month, instructing them to forward, with their detailed reports of the operations at their respective stations, concise statements of their views concerning the service, "(A) *From the stand-point of preventive medicine*, as tending to secure (1) a better sanitary condition of vessels; (2) a heightened sense of public-health responsibility among shippers and common carriers; (3) more efficient safeguards against the spread of epidemic diseases; and (B) *From an economic stand-point*, as tending to prevent unnecessary interruption to travel and traffic during the existence of such diseases." In answer to this request the following

*The sanitary patrol-boat and the two launches above-named were delivered to the director at Memphis July 7, and the remaining launch, the Picket, was received at Cairo July 13.

† At the Vicksburg Station, three and a half miles below the city, every person on duty during the season suffered from malarial fever; one inspector was permanently invalided and obliged to resign, and at one time for a period of nearly three weeks there was not a single well person at the station. This was attributed, in part, to the insufficient protection afforded by the tents in which the people were housed at this station.

from Inspector Parham was received among others, and is here furnished as embodying the result of the practical experience of one of the most intelligent and impartial of those engaged in the service.

REPORT UPON THE OPERATIONS OF INSPECTION STATION NO. 2.

[BY F. W. PARHAM, M. D., *Inspector in Charge.*]

I have been requested from the office of the director to make a statement of my views concerning the inspection service now closed. I will, perhaps, make myself clearer by prefacing my remarks by a brief description of the manner in which inspections have been performed at New Orleans and at this station. Having been assigned to duty at New Orleans for the months of June and July, and at President's Island (below Memphis) during August and September, I can speak from personal observation at both places.

In New Orleans boats were requested to notify us, as soon after arrival as possible, when it would be convenient for the inspector to make the necessary examination. This time was generally after the cargo had been discharged and the rubbish removed from the hold and deck. The boat was examined throughout, from keelson to "texas." If her condition was found in all parts satisfactory, she was permitted to take on cargo; but if the bilge, hold, or other part *inaccessible* in a *loaded* boat was discovered in insanitary condition, directions were given for removing objectionable features, and a second visit was paid to ascertain what effort had been made to carry out instructions before loading began. Finally, just before departure an examination was instituted especially to determine the character and condition of cargo,* to visit those portions of the boat not seen in the previous inspections, to see all sick persons on board, and to furnish the certificate filled out according to the facts.

At this station—President's Island—the manner of proceeding was somewhat different. Boats from Vicksburg and above were treated as in New Orleans, excepting that only one inspection was required, all desired information being attainable, owing to the fact that during the summer season these boats do not carry much freight in the holds. With reference to boats from New Orleans, if the New Orleans inspector had certified that the condition of boat, her cargo, and passengers was entirely satisfactory, or if, this not being the case, the inspector at Station No. 1 had indorsed on the certificate, as the result of his examination, that all objections of the New Orleans inspector had been removed, it was not considered necessary at this station (No. 2) to detain the boat so long as would be required to enable the inspector to make a thorough reinspection; but any changes in cargo and passengers since leaving last station were noted, all sick persons on board were personally examined, and the diagnosis stated in the form.

If a boat had not an originally "clean" bill nor a proper indorsement by last inspector, she was examined with reference to those points objected to by the last officer of the service, or, no matter what the certificate evidenced, if the boat was one whose officers had in any way betrayed a desire to cover up insanitary conditions, such search was made as was necessary to determine the actual facts, and the result was stated on her bill without alluding to the conduct of the officers. Thus the service has been carried on; the foundation principle, that the power of the inspector was derived solely from the will of the people as expressed through their State or local health authorities in demanding that boats should comply with the regulations of the National Board of Health, has been fully recognized, and nothing unreasonable has been asked and the smallest possible inconvenience and detention of boats have been entailed.

SANITARY AND ECONOMICAL RESULTS OF THE SERVICE.

I am of opinion, from experience and reflection, that some practical good has been accomplished by the operations of the service this summer. I will discuss the question from the two points of view suggested in the letter of the director of the service, namely:

A. *Preventive Medicine;* B. *Economy.*

As a measure of preventive medicine this service has secured an improved sanitary condition of steamboats and barges. The parts of a boat most likely to accumulate dirt and filth and those to which naturally the least attention is generally paid are the bilge, the water-closets (particularly those on lower deck, used by roustabouts), and the crew's quarters. The hold is generally cleaned out after unloading, but the bilge, with the exception of occasional pumpings, is only at long intervals thoroughly purified; the water-closets for passengers are usually tolerably well cared for, but those

* It should be stated that especial attention was paid to the following articles of cargo: Coffee, sugar, fruits, and other articles from tropical ports; second-hand bedding and clothing, rags, and paper-stock. The sanitary history of all shipments of the last four articles—namely, second-hand bedding and clothing, rags, and paper-stock—was carefully inquired into, and the information elicited was entered upon the certificate of inspection for the benefit of intermediate ports, as well as the port of destination. The publicity thus given led to the almost total abandonment of shipments of this dangerous character during the summer months. M.

used by the deck-hands, being more indecently and frequently patronized, are very often found in very filthy state; the quarters for crews, especially those on main deck, are in many instances badly ventilated and kept closed for the most part of the day, furnished badly and unused to cleanliness, or, indeed, to decency.

The practical benefits secured by the inspections are: (1) The attention of captains has been *repeatedly* called to these insanitary conditions and to the necessity of correcting them; (2) they have been told *how* this could be done, and (3) they have generally *attempted* some improvement and in many cases succeeded in satisfying the demrnds of the service. Second inspections have often revealed the turning up of the dunnage-boards for the removal of decomposing grain and other organic matters and mud, and the improvement of the odor of bilge-water by the (total or partial) substitution of fresh, with the addition of copperas; the cleansing of the water-closets and their disinfection with copperas solution, lime-wash, or chloride of lime; the better ventilation of sleeping apartments, and greater attention to neatness.

Sometimes boats remained in port so short a time that little could be accomplished before departure, and it was not deemed prudent to invite opposition by harshness or the attempt to enforce the execution of the measures advised. Under these circumstances the facts were stated on certificate and the captain requested to have the directions carried out as far as possible *on the way up* the river. This course had to be pursued with some steamboats and with many barges, and was found to work well. At this station I have examined barges, certified to by inspectors below as in bad sanitary condition, in an advanced state of purification, and the progress of the work could in some instances be traced. It is true we have met with objections and refusals to comply with our regulations, but in the main an unexpected acquiescence has been experienced and the sanitary conditions of boats and barges has been improved. It may prove of interest to glance at the agencies that have brought about this desirable result.

(1.) Letters were early in the season addressed to the presiding officer of steamboat and transportation companies in Saint Louis, Cincinnati, and elsewhere, requesting them to issue such orders as would facilitate the work of the inspectors. In response to this request written orders were sent to the different boats of the Saint Louis and New Orleans Anchor Line, verbal instructions to the Saint Louis and New Orleans Transportation Company (barges), and to others. These orders materially assisted the efforts of the inspectors, as they were generally carried out.

(2) Letters were sent the New Orleans agents of barge lines requesting them to have their barges overhauled as thoroughly as possible and cleaned out in Saint Louis, where the work could be better and more expeditiously accomplished. In complying with this request the managers aided us by starting out the barges for the summer trade in much better condition than heretofore.

(3) The spirit of rivalry among boats in matters of cleanliness was stimulated by the watchfulness of the service.

(4) The fear of detention or of exclusion from certain landings, when no certificate had been obtained, also operated to effect the end in view.

(5) The experience of the past called attention to the possible renewal of the establishment of onerous and hurtful quarantines, and the results of 1879 seemed to promise an avoidance of these evils for 1880, at the same time that the public health was more perfectly protected. The steamboat interest deemed it wise to foster a service moderate in its demands and approved by the people. I can offer no evidence that the service has secured "a heightened sense of public-health responsibility among shippers and common carriers," save (1) a manifest desire to understand what was required; (2) the readiness in many cases compared with the unwillingness in others with which they complied with all the rules and regulations; and (3) the opinions pronounced by some interested in the *protection* of trade as to the necessity of imposing such *restraints* upon commerce as the preservation of the public health demanded. *Taken in connection with* (4) the high and *impartial* stand in the outset assumed by the National Board of Health, offering a hope that a middle course might be steered with safety between the protection of health and the destruction of business, *enlightened* the people and called a halt to the selfish tendencies of the business community.

C.—MORE EFFICIENT SAFEGUARDS AGAINST THE SPREAD OF EPIDEMIC DISEASES ALONG THE VALLEY.

The *frequent* repetition of inspections diminishes the chances of transportation of infected persons or things by affording increased opportunities to detect what might have eluded the vigilance of preceding inspectors as to existence of articles of freight of doubtful nature, and to discover the development *in transitu* of contagious and infectious disease.

The number of stations and the accessories there found provide for the better care and treatment of the sick, which shot-gun quarantines recklessly ignore. The service

provides for the employment of an extra physician and nurses to obtain these desirable ends. It also secures the more complete isolation of the *sick* from the *well* of the boats and from communities. Medical attendant and nurses are debarred communication with the station and the outside world (except under necessary restrictions), and are enjoined not only to keep vigilant watch over the condition of the sick, but also to restrain their movements within certain limits. The arrangements at Station No. 2 permit the accomplishment of this by means of a hospital-float, moored at a convenient but safe distance from the inspection station, and of hospital-tents. Comfort and isolation can thus be obtained.

The housing and care of the healthy or uncompromised among the passengers, who are retained for observation and isolated until such time as it is deemed safe for them to proceed, are also amply provided for, as is likewise the efficient treatment of infected vessels.

This station, situated near the southwestern extremity of President's Island, offers peculiar advantages for the objects above enumerated. Distinct from the mainland, distant ten miles from Memphis, and sparsely populated, furnished with all necessary appliances and conveniences, it is possible to accomplish the most satisfactory attainable isolation.

Considered from an "economic stand-point," the service certainly commends itself to the good-will of the steamboat interest and the public generally.

At least fifty authentic cases of yellow fever occurred in the city of New Orleans in the summer and early fall of 1879, and the prejudiced even must admit that there was an *unusual lack* of absurd and onerous quarantines, which so often entail suffering and pecuniary loss. I think I do not go too far in asserting that part at least of this desirable result had its source in the disinterested efforts of the National Board of Health.

Further, comparison of the amount of business transacted by river and rail in 1879 with that done in years preceding the inauguration of this service will demonstrate that the confidence of the people has been enlisted, and that hasty and ill-advised quarantines did not cause much interruption to business, though danger at one time (in 1879) undoubtedly threatened.

The history of the circumstances connected with the arrival in New Orleans on July 6 (when all the conditions were favorable to the development of yellow fever) from Rio de Janeiro of the infected ship Excelsior will prove the same proposition for 1880. The action of the National Board of Eealth in promptly notifying constituted authorities, and the measures taken to prevent any spread of infection from New Orleans, together with the action of local boards of health in menaced communities in co-operation with this service, undoubtedly averted panic, established confidence, and obtained exemption from disease without seriously hurting business.

Finally, the service invites the approbation of the shipping interest from the fact that, during 1880, the *only expenses* incurred by boats were for the purchases of disinfectants, for the work done by the boat in cleaning, and for consumption of fuel and loss of time, made necessary by detention at intermediate stations.

WORK PERFORMED.

During the season, as above—namely, from May 25 to October 15, inclusive—there were inspected 1,514 vessels, with an aggregate capacity of 1,234,450 tons, and carrying 81,395 persons, including passengers, officers, and crews. Special inspections of coffee shipments—2,612 by river and 2,552 by rail—were also made at the port of New Orleans, where, also, 26 passenger and 525 freight trains were inspected; making a grand aggregate of 89,274 river and rail inspections by the service.

The following tables exhibit this work in detail:

	Inspections at—				Totals.
	New Orleans.	Bayou Sara.	Vicksburg.	Memphis.	
Of vessels	387	297	365	465	1,514
Persons thereon	27,828	16,787	20,305	16,475	81,395
Railroad passenger trains	26				26
Persons thereon	650				650
Railroad freight trains	525				525
Coffee shipments	5,164				5,164
Totals	34,580	17,084	20,670	16,940	89,274

Aggregate number of persons inspected.

Passengers, officers, and crew, by river	81,395
Passengers only, by rail	650
Total	82,045

Aggregate freightage inspected.

	Tons.
Tonnage of vessels	1,234,449.87
Railroad freight	105,127.00
Total	1,339,576.87

Among the 82,045 persons inspected only 118 cases of sickness were found, as follows:

Intermittent fever	84
Remittent fever	9
Chronic malarial toxæmia	5
Dengue	7
Acute dysentery	3
Chronic diarrhœa	6
Phthisis pulmonalis	1
Senile debility	1
Hives	2
Total	118

Of these the majority were found during the month of September, and mainly among the crews of towboats. Only one death (congestive malarial fever) occurred from disease during a voyage. Five cases of dengue were taken from the towboat Raven in the latter part of August, and treated in the floating hospitals at the Vicksburg station. (See detailed report.)

THE FLOATING HOSPITALS.

Two reasons induced the director, soon after the opening of the inspection season, to recommend the purchase of small flatboats out of which to extemporize floating hospital-wards to be attached to the inspection stations. The first of these was the more perfect isolation which could be secured by the reception and treatment of cases of infectious or contagious disease on such floats; the second was that their use overcame the only opposition met with in the location of the stations. This opposition was of a most pronounced character at every place except on President's Island, near Memphis, and was based on the natural fear of those living near the proposed sites of the stations that these would become centers of infection if yellow-fever cases, for example, were there taken ashore for treatment.

Three of these boats were procured and fitted up with accommodations for four patients and two nurses each. One was assigned to each of the three stations, Bayou Sara, Vicksburg, and Memphis. Those for the two former stations reached Vicksburg only a day or two before the arrival of the towboat Raven, and were at once used for the reception of her suspicious cases.

While the only structures which could be obtained during the past season were objectionable in many respects—small, fragile, leaky—the result of the experiment is such as to demonstrate that floating hospital-wards, suitably constructed, must hereafter be considered indispensable features of all properly equipped inspection stations.

PROPERTY ON HAND.

There is now on hand, in charge of the river-inspection service, the following property of the National Board of Health, described in detail in the accompanying inventories:

One iron steamboat, the H. H. Benner, fitted up with steam disinfecting apparatus and hospital-ward for twenty-four patients. Used for sanitary patrol duty.

Three steel-hull steam-launches, the Lookout, Sentinel, and Picket, for service at the inspection stations.

One steamboat hulk, the J. W. Vanzant, used for inspection station in the river below Cairo, Illinois.

Five skiffs, with oars, used for boarding tows and barges.

Eight hundred and seventy-five canvas tents (worn); originally used for the camps during the Memphis epidemic of 1879.

Twenty-three United States Army hospital tents (new).

One hundred and eighty-five barrels of roll sulphur.

Twenty-three barrels of copperas.

Outfits and equipage for three inspection stations.

Medical and hospital supplies for patrol-boat and stations.

Furniture, carpets, &c., in the director's office at Memphis.

Such of the above articles as are not in use are safely stored at Cairo, Memphis, and Vicksburg, in readiness for the next season.

NOTABLE FEATURES OF THE SEASON OF 1880—THE EXCELSIOR AND RAVEN AFFAIRS.

YELLOW FEVER ON THE EXCELSIOR.

On the 12th of July, while the director was *en route* for New Orleans on the patrol boat Benner, intelligence was received of the outbreak of yellow fever on the Swedish bark Excelsior at the port of New Orleans. Instructions were at once telegraphed to the various stations enjoining redoubled vigilance in the inspections, especially of tows and barges, and calling attention to Rule 4, Section II, Code B, of the *Regulations River Inspection Service*, to wit: "During the existence of yellow fever *all cases of fever* are to be regarded with suspicion," &c.

As a result of this outbreak the Tennessee State board of health issued the following order:

Official notice from the State board of health.

OFFICE STATE BOARD OF HEALTH,
Nashville, Tenn., July 14, 1880.

Whereas one death from yellow fever and two other cases have occurred in New Orleans among the crew of the coffee-ship Excelsior, from Rio de Janeiro; and

Whereas the history of said ship, as recited at a meeting of the Louisiana State board of health, held in the city of New Orleans on the 12th instant, conclusively shows that the vessel and her cargo are infected with yellow fever; that her infected cargo is now stored in a warehouse in that city; and that her captain, some members of her crew, and a large number of visitors, as well as the persons (seventy-five or more) who were engaged on and about said infected vessel in breaking out the cargo, and in handling, draying, and storing her infected merchandise, are scattered throughout said city; and

Whereas this board is charged with the duty of protecting the public health of this commonwealth against the introduction of contagious and infectious diseases, and believes such introduction is now seriously threatened by the above-described condition of affairs at New Orleans: It is therefore hereby

Ordered: 1. That on and after the date of this publication no freight car over any railroad, nor any steamboat of other water-craft departing from the city of New Orleans after the 15th day of July, 1880, and until further orders, shall be allowed to enter the State of Tennessee, nor to make a landing upon the borders of the State for the purpose of transacting any business whatsoever, unless said car, boat, or water-craft shall present to the proper officers of this board a certificate from an officer or agent of the National Board of Health to the following effect:

(*a*) That said officer or agent of the National Board of Health has personally examined the freight of such car, or the cargo, passengers, officers, and crew of such steamboat or water-craft, and has satisfied himself of the freedom from infection of said vehicle and its contents (persons and things).

(*b*) That the freight or cargo comprises none of the following articles of the list recommended by the Louisiana State board of health to be subjected to obligatory quarantine and purification, to wit: Clothing, personal baggage and dunnage, rags, paper stock, hides, skins, feathers, hair, and all other remains of animals, cotton, hemp, woolens, and coffee; nor any of the following additional articles, which are hereby declared contraband of quarantine in this State, to wit: Second-hand bedding, clothing, upholstered furniture and textile fabrics, moss, jute, and "excelsior," tropical fruits and productions.

2. That any of the articles above enumerated may be shipped as freight from New Orleans, and transported through the State of Tennessee by rail, if carried in close box-cars, securely locked, and in charge of an officer or an agent of this board. The expenses of such officer or agent shall be defrayed by the railroad transporting such goods.

3. That this order shall be enforced on the railroads at the southern State line by the officers of the board appointed for such purpose; and at Memphis, and elsewhere upon the Mississippi River, by the wharfmaster or other duly authorized officer. The penalties prescribed by law for the violation or infraction of the orders of this board will be rigidly enforced in carrying out this order.

T. A. ATCHISON, M. D., *President.*
W. M. CLARK, M. D., *Secretary.*
COL. E. W. COLE,
JOHN JOHNSON,
J. D. PLUNKET, M. D.,
J. M. SAFFORD, M. D.,
G. B. THORNTON, M. D.,
E. M. WIGHT, M. D.,
Members.

Similar action was also taken by the State board of health of Mississippi and by the city board of health of Memphis. The order of the former board required all passengers by rail entering the State of Mississippi from New Orleans to be provided with a certificate of inspection from an inspector of the National Board; while the Memphis order required the domiciliary registration of all passengers by river arriving in Memphis from Vicksburg or below. These various orders entailed additional labor and imposed further responsibilities upon the inspection service; but it was a source of gratification to meet with such recognition of the value of the service as that which occurs in the following "open letter," published August 14, by the members of the Tennessee State Board of Health, and which letter, together with some of the expressions of opinion elicited by its publication, are included in this report as serving to explain the relations of the inspection service to municipal and State boards:

AN OPEN LETTER TO HIS EXCELLENCY THE CHIEF EXECUTIVE OF THE STATE OF LOUISIANA.

MEMPHIS, TENN., *August* 14, 1880.

SIR: In view of recent public and official strictures upon the Tennessee State board of health, on account of its order* issued July 14, concerning the sanitary supervision of intercourse with New Orleans during the existence of a threatened danger to the public health of the Mississippi Valley, it seems fitting that the representatives of the State board resident in this city, and who are largely responsible for that order, should take some cognizance of those criticisms.

It ought to be entirely unnecessary to say that nothing but the kindliest feelings do or can exist toward New Orleans from Memphis and the State of Tennessee. We believe our interests, if not identical, are at least so much in common, that whatever helps or hurts New Orleans helps or hurts Memphis and the rest of the valley. If, however, New Orleans brings harm to herself by neglecting proper precautions (for example, in the admission of vessels from ports infected with yellow fever), then the law of self-preservation demands that the rest of the valley, which has been so often scourged through New Orleans, shall take such steps as may be needed to confine that harm, if possible, to the community which has invited it through negligence or indifference.

While such steps may be taken reluctantly, and with regret that the necessity for them exists, the authorities charged with the protection of the public health cannot hesitate to do their sworn duty. It was with this conviction that the order in question was issued—an order which, it should be noted in passing, applied mainly to articles described in the printed rules and regulations of the Louisiana State board of health as being dangerous under such circumstances as those attending the Excelsior affair, and which that board declares should be subjected "to obligatory quarantine and purification." (See *Rules and Regulations, Louisiana State Board of Health*, 1880, *page* 8.)

That the order of the Tennessee State board of health was wise, timely, and beneficent in its workings there is ample evidence, aside from any interested testimony of the board itself. It is not too much to say that its prompt publication arrested a fast-growing tendency to panic and preparation for local "shot-gun" quarantines, begotten of the alarming announcement of an outbreak of yellow fever on a coffee-ship in New Orleans, the details of which were recited at a meeting of the Louisiana State Board of Health, on July 12, and upon the published report of which the Tennessee order was based. Had the order been longer delayed, or not issued at all, past experience forces the conviction that travel would have been impeded and traffic more or less completely interrupted.

That the requirements were not made more stringent and did not impose greater restrictions upon commercial and personal intercourse between New Orleans and the State of Tennessee, is due solely to the confidence reposed in the inspection service of the National Board of Health, both at New Orleans and throughout the valley. In the absence of this agency it would have been the imperative duty of the State board, and of local boards throughout the State, to recommend the absolute prohibition of all freight and a quarantine of observation for all compromised passengers, from New Orleans, until a sufficient period had elapsed to determine whether the five cases and three deaths from yellow fever among the crew of the Excelsior and her 3,600 sacks of presumably infected coffee were to be the seeds of another epidemic—as the single case from the Valparaiso was the seed of the epidemic of 1873, with its harvest of 16,000 cases and 4,000 deaths in Shreveport, and Memphis, and Montgomery, Ala., and Calvert, Tex., and other places; or as the single case from the Emily B. Souder was the insignificant and uncared-for beginning of the widespread pestilence of 1878.

It is submitted to your excellency, and to the public, that the inconvenience and pecuniary losses caused by this admission of a vessel from an infected port into the

* The order above quoted.

port of New Orleans in midsummer, bear no comparison to the cost (aside from the question of human life) which similar action has entailed in the past.

How far the State board of health of Louisiana is to be credited with the good fortune that an epidemic has not yet resulted from the Excelsior it is not our province to discuss. But it is entirely proper to assert, in the light of what has since occurred, that the orders of the State boards of health of Mississippi and Tennessee averted a panic, prevented the interruption of travel and traffic, and restored confidence throughout the Valley of the Mississippi in many communities which have not yet forgotten the history of the year 1878.

Very respectfully,

G. B. THORNTON, M. D.,
JOHN JOHNSON,
Members Tennessee State Board of Health.

The following letters, among others, were received in reply to the foregoing, and the director is indebted to the courtesy of Dr. Thornton and the Hon. John Johnson for the copies here given:

[From his excellency the governor of the State of Mississippi.]

EXECUTIVE DEPARTMENT,
Jackson, Miss., August 18, 1880.

GENTLEMEN: I have the honor to acknowledge the receipt of your communication of the 14th instant, inclosing copies of your letter of same date to the governor of Louisiana, and official order of the State board of health of Tennessee, dated July 14, and soliciting my views on the general subjects involved therein, especially on the relations of New Orleans to the Mississippi Valley in the matter of excluding vessels from infected ports during the dangerous season, and upon the value of the inspection system as an agency for obtaining and imparting information to threatened communities, by which they may be enabled to take prompt and intelligent action for prevention with the least possible interruption to the movements of merchandise and persons.

Upon the general subject involved, I do not hesitate to express the opinion that the State board of health of Tennessee, with the lights before it, and in view of the lamentable experience of 1878 and 1879, was fully justified in the issuance and publication of the order referred to. It had the effect of forestalling unnecessary local quarantines and preventing a recurrence of the excitement of 1878, without seriously affecting the commerce of the country. As New Orleans is the gateway through which yellow fever is introduced into the adjacent States and those bordering on the Mississippi River, it certainly devolves upon the authorities of that city to exclude vessels from infected ports during the dangerous season. If they should refuse, neglect, or fail to do this, or if fever should find its way into New Orleans, notwithstanding all proper and reasonable efforts to exclude it, it then becomes the duty of those charged with the protection of the health of other States and communities to adopt such measures as may be necessary to prevent its introduction into such States and communities. The system of inspection is, I think, of great value, if faithfully carried out. Information thus obtained will generally be received with more confidence than that coming from the local authorities of suspected communities. By means of a thorough system of inspection all threatened localities may be protected without serious interruption to the movements of merchandise and persons destined to points exempt from the dangers of epidemic disease. The dignified and manly tone of your letter commends it to the respectful consideration of all concerned, and I see nothing in it to give offense to any. An earlier reply to your favor was prevented by my absence, and I have taken the first opportunity since my return to write.

Very respectfully, your obedient servant,

J. M. STONE.

[From his excellency the governor of the State of Tennessee.]

EXECUTIVE OFFICE,
NASHVILLE, TENN., *August* 16, 1880.

GENTLEMEN: At your request I have examined the "Official notice from the State board of health" and your joint letter to the governor of Louisiana, and it seems to me the measures adopted for the protection of our people are wise and prudent, and that your letter, while respectful and cordial, is conclusive.

Respectfully and truly,

ALBERT S. MARKS.

[From the president of the State board of health of Arkansas.]

STATE BOARD OF HEALTH,
LITTLE ROCK, ARK., *August* 16, 1880.

GENTLEMEN: In reply to yours of the 14th, allow me to say that I fully indorse the action of your board in issuing the order of July 14, 1880, for the same reasons so fully set forth in your published "open letter" to the governor of Louisiana. The Arkansas board of health relied on the wise and efficient precautions of the National Board of Health for protection against the spread of yellow fever in the matter of the Excelsior, and have no reason to regret this confidence. I am still of the opinion that the national government, with the co-operation of the States, is as fully competent to protect its people from the importation and spread of infectious or contagious diseases as it is in keeping from our shores an armed enemy.

Very respectfully, your obedient servant,

A. L. BREYSACHER, M. D.,
President Arkansas State Board of Health.

[From the State board of health of Mississippi.]

HOLLY SPRINGS, MISS., *August* 17, 1880.

GENTLEMEN: In answer to your letter of 14th August, asking my opinion on matters therein contained, I would say that I deem the inspecting system instituted by the National Board of Health for the protection of the people of the Mississippi Valley a necessity, not only to prevent the introduction of yellow fever, but that the traveling public and the commerce of the country might not (in a great measure) be interrupted.

I think it would add greatly to the safety of the people of the Mississippi Valley that no vessels from a place infected with yellow fever should be permitted to enter the port of New Orleans during the heated term or dangerous season.

Yours,

F. D. DANCY,
Member of Mississippi State Board of Health.

[From the secretary of the State board of health of Massachusetts.]

STATE BOARD OF HEALTH, LUNACY, AND CHARITY,
STATE-HOUSE, BOSTON, *August* 24, 1880.

GENTLEMEN: In reply to your favor of the 14th instant, it gives me pleasure to say that the action of the Tennessee State board of health has been, in my opinion, in all respects judicious in the matter of quarantine regulations referred to. It seems to me too clear to need the statement that the only protection against pestilence and ruin of commerce for the Mississippi Valley lies in thorough inspection under the control of such a body as will command universal respect and confidence.

I am, very sincerely, yours,

CHAS. F. FOLSOM.

[From Dr. Stephen Smith, of New York City.]

NEW YORK, *September* 1, 1880.

GENTLEMEN: I have read your "open letter to his excellency the chief executive of the State of Louisiana" with great interest, and submit the following criticism upon the subjects embraced in it. I do so with more confidence because I have recently visited many of the principal towns of the Mississippi Valley, and have freely discussed matters pertinent to your letter with members of State and local boards of health and with leading citizens. The feature of your communication which impresses me most forcibly is the statement that the interests of the communities of the Mississippi Valley are identical with those of New Orleans—"that whatever helps or hurts New Orleans helps or hurts Memphis and the rest of the valley." This great practical truth is fully recognized in regard to every branch of industry and of trade. The Mississippi Valley is acknowledged by competent authority to be capable of supporting the largest population and developing the greatest amount of material wealth of any equal territory in the world. New Orleans by location is, and doubtless will continue to be, the commercial metropolis of this region. It follows that the prosperity of this favored city must depend upon the growth of the population of the river States and the development of their immense natural resources. The interests of the people of the valley and of its commercial center are therefore identical. But what is the chief obstacle to-day to the progress of New Orleans and of the Lower Mississippi in population and industrial development? Everywhere in that region thoughtful citizens reply, "Yellow fever." Said an intelligent physician of large experience: "The dread of this pestilence is so deep-rooted and universal that the present popula-

tion is unsettled and immigration prevented." A large cotton-planter of Louisiana remarked: "If we could give satisfactory guarantees that yellow fever would never visit the valley again, we could raise annually 20,000,000 bales of cotton where now we raise our present crop. One great want is laborers." This fear of yellow fever may be irrational, but nevertheless it exists, and cannot be removed by argument, persuasion, or coercion. In the opinion of the most sagacious citizens only measures which give the most satisfactory proof that they are capable of preventing a return of the epidemic will allay public apprehension. And of all the measures proposed none will satisfy the public demand but those which secure *positive non-intercourse of the well with infected materials and persons.*

Whatever theories medical men may hold as to the origin and mode of propagation of the disease, the people of the valley have determined upon but one mode of protecting themselves against it, viz, *non-intercourse with the infectious material.* And civil and health authorities throughout the valley recognize the justice of this demand, in the absence of any more satisfactory measure, and direct all their efforts to accomplish this object. Naturally they turn their attention first to the mouth of the Mississippi River, through which the commerce of infected ports chiefly enters the valley, and through which the infection has frequently come to towns far up the valley in its most virulent form, as the point where defensive and preventive measures can be most easily placed and effectively administered. Here, in a well equipped and appointed establishment, with expert sanitary officers and acclimated laborers, every vessel from an infected or suspected district or port could, with the least delay to travel and obstruction to commerce, undergo such treatment as would relieve her passengers and crew, cargo and ship, of every particle of infection.

But if such precautions are not taken at the mouth of the river as in the judgment of the health authorities of the valley will intercept and exclude all infected persons and things from vessels from foreign ports, it is plainly the duty of such authorities to erect defenses looking to the same end within their own jurisdiction. Such measures must necessarily be cumbersome as compared with the former, and far more obstructive of travel and commerce. Hence the only alternative is the organization of a system of inland inspection which shall intercept and quarantine infected persons and merchandise in transit and furnish timely information to threatened communities. If neither of these measures are carried out in good faith, and infected merchandise is allowed to pass from commercial centers into the various avenues of trade, authorities are undoubtedly justified in forbidding its entrance into their communities, and in employing such agencies as will most effectually accomplish that object. The hardships which such stringent measures impose upon commerce are not to be considered when they relieve public alarm and surely prevent both panic and a possible epidemic.

In conclusion, I may remark that the opinion of the health and civil authorities throughout the valley seem to be unanimously in favor of the most efficient quarantine establishment at the seaboard which modern science and adequate means can provide. It is the belief that if all further importation of yellow fever can be prevented, it will not be difficult to exterminate whatever germs may remain in this country. But it is not common justice to impose upon a single State the obligation of providing and maintaining a quarantine which protects ten populous States from the direct importation of yellow fever from foreign ports. Nor is it compatible with public safety to commit the administration of such a quarantine to the local influences which surround it. On the contrary, a quarantine which protects such an enormous population from pestilence and such diversified industrial interests from depression, ought either to be established and maintained by the joint action of the several States interested or by the general government.

Very truly yours,

STEPHEN SMITH.

SICKNESS ON THE TOWBOAT RAVEN.

At 3 o'clock p. m., August 29, a cipher telegram was received by the director from Inspector Rice, at the Vicksburg inspection station, stating that he had removed five cases of suspicious fever from the towboat Raven, which boat left New Orleans August 24; that the captain refused to remain long enough to enable him (Rice) to decide as to the character of the sickness; that the rest of the crew, believing it to be yellow fever, threatened to desert the boat; and asking instructions as to the course to be pursued. He was at once telegraphed to hold the boat and all on board, if possible, until satisfied that she could proceed with safety to the public health; but that if there was danger of the possibly infected crew deserting to allow her to proceed after securing a promise from the captain to make no landing short of the Memphis inspection station. Meanwhile Inspector Reilly was instructed to have the sanitary patrol-boat Benner in readiness to proceed, with all possible dispatch, down the river to intercept and take charge of the boat should she leave the Vicksburg station before the character of the sickness was determined. A second dispatch from Inspector Rice, announcing that the Raven had left the station, was received at nine o'clock p. m., and the Benner departed forthwith upon her mission.

Dr. Reilly's orders were to the following effect:

OFFICE OF DIRECTOR, RIVER INSPECTION SERVICE, N. B. H.,
MEMPHIS, TENN., *August* 29, 1880.

DOCTOR: The information telegraped to-day by Dr. Rice from the Vicksburg inspection station renders it necessary that prompt action be taken to ascertain forthwith the exact condition of the tow-boat Raven and her barges. You will therefore take the sanitary patrol-boat Benner with all possible dispatch down the river to intercept said boat. Should you find positive evidence of infection on board, you will take possession of the boat and barges and enforce such measures as may be necessary to prevent any spread thereof to the shore at any point in the valley. You are intrusted with the widest discretion in the construction and fulfillment of this order.

Engage another pilot in addition to Captain Thompson, and two engineers, together with such other persons as may be necessary to enable you to run the boat night and day.

You will include the expense of hiring all these persons (other than those borne on the regular pay-roll of the boat) in your traveling-expense account, as well also as any other expenditures you may find it necessary to make in the prosecution of this duty.

If it becomes necessary to take the Raven back to the Vicksburg station, you will remain there long enough to assist Dr. Rice in getting the quarantine equipment of the station on a proper footing, and will correspond fully and promptly with this office both by mail and wire.

As soon as possible you will return to Memphis, reporting in person to this office.

Very respectfully,

R. W. MITCHELL,
Member N. B. H. and Director River Inspection Service.

Dr. F. W. REILLY.
Inspector National Board of Health, Memphis, Tenn.

The weekly report of inspections at New Orleans, received the next day, August 30, notes that one of the barges of the Raven had lain alongside a Spanish steamer, the Yruzac Bat, delivering wheat; and as this vessel had already been the subject of correspondence between the director and the Louisiana State board of health (on account of her discharging upon the New Orleans levee ballast taken in at Havana, an infected port), additional importance was thus attached to Inspector Rice's action.

The Raven was met and boarded about midnight of August 30, nearly opposite Lake Washington, Mississippi, some 300 miles below Memphis and less than 100 miles from Vicksburg. Two of her crew were reported sick, but upon examination one was pronounced a malingerer and the other was found to be suffering from well-marked quotidian intermittent fever. The boat and barges were found in good sanitary condition, and she was allowed to proceed upon her voyage, with instructions to report at the Memphis inspection station for further orders. The Benner arrived at the Vicksburg Station in the afternoon of the 31st August, and during the night returned to Vicksburg, whence the following dispatches were at once transmitted throughout the valley:

VICKSBURG INSPECTION STATION, N. B. H.,
August 31, 1880.

The cases from the towboat Raven have been under continuous observation during the past seventy-two hours, and are now positively declared not yellow-fever or other contagious disease.

C. A. RICE, M. D.,
Inspector National Board of Health.

U. S. STEAMER H. H. BENNER, N. B. H.,
Off Vicksburg, Miss., August 31, 1880.

I have personally examined the patients from the towboat Raven, and also the clinical record of said patients for the past three days, and fully concur with Dr. Rice in the above declaration.

F. W. REILLY, M. D.,
Inspection Service.

An examination of the clinical record of these cases fully justifies Inspector Rice in his action. It reveals a febrile disease of a single paroxysm of from sixty-eight to seventy-two hours' duration, and during which the temperature rose to 105.5°, accompanied by a slow pulse (62-72) in one case, under observation from the beginning of the attack; the pulse was 92 and temperature 105° eighteen hours after pyrexia began, and sank to 70, 68, 62, with a temperature ranging between 105° and 101.2°. For the rest, there was supra-orbital headache; severe rachialgia; a white tongue with red

edges and tip; gums very red and slightly swollen; conjunctivæ injected. At the close of the second day's observation, however, the following negations warranted the exclusion of yellow fever from the diagnosis: No epigastric tenderness or distress; no hemorrhages; no icterus; neither suppression of nor albumen in the urine even of the cases of longest duration (seven days). It is probable that the disease was dengue, which had already assumed epidemic proportions in New Orleans at the time the Raven left that port.

The cases were treated on the floating hospital wards at the station, and during the period of uncertainty no intercourse was allowed with the shore or with other vessels. Notwithstanding the precautions taken, however, and the commendable reticence of Inspector Rice, it was at once rumored that there was yellow fever at the Vicksburg Station and upon a tow-boat making her way up the river. As in the case of the John D. Porter, in the year 1878, from Greenville to Vicksburg, the river communities were found in a panic of alarm and organizing "shot-gun quarantines." The passage of the Benner and a knowledge of her errand allayed this excitement, and the publication of the dispatches above given speedily restored confidence. This individual service is in itself ample return for the expenditure on account of the sanitary fleet.

VERDICT OF THE VALLEY UPON THE SERVICE.

With the view of ascertaining the estimates of the value set upon this service by those most directly concerned and best qualified to judge—such estimates to form the basis, in part, of any recommendations to the Board by the director—letters of inquiry were addressed to various organizations and representative citizens soon after the close of the season. In response thereto the following action and expressions were obtained:

Proceedings of the Memphis Cotton Exchange with reference to the protection of the Public Health.

At a called meeting of the Memphis Cotton Exchange, held this 30th day of October, 1880, the following proceedings were had:

The members were called to order at 3 o'clock p. m. by the president, D. P. Hadden, who stated that the object was to consider and take action upon a communication from Dr. R.W. Mitchell, the resident member of the National Board of Health, and under whose direction had been conducted an inspection service which the speaker believed had been of inestimable value to Memphis and all other communities in the Mississippi Valley during the past summer. Without detaining the members, he would call on the secretary to read Dr. Mitchell's letter, which is here appended.

NATIONAL BOARD OF HEALTH,
INSPECTION SERVICE, OFFICE OF THE DIRECTOR,
Memphis, Tenn., October 28, 1880.

MY DEAR SIR: Before closing my final report upon the operations of the river inspection service of the National Board of Health for the season of 1880, I am desirous of obtaining a formal expression of opinion upon the merits and usefulness of the service, in order to guide me in my recommendations to the Board as to its future policy upon the question of continuing or relinquishing this branch of its work. As the representative commercial body of this city, it seems to me fitting that such expression should be formulated by the Cotton Exchange, and I have, therefore, to ask that you present this communication to its members at your early convenience.

It is simply desired that the Exchange state, by resolution or otherwise, whether the inspection service has proved to be of sufficient value to the commercial interests of Memphis and the Mississippi Valley to warrant the National Board of Health in maintaining it during the next season.

Very respectfully,

R. W. MITCHELL,
Member National Board Health, Director Inspection Service.

SAM. M. GATES, Esq.,
Secretary and Superintendent Memphis Cotton Exchange.

* * * * * * *

The president then asked the meeting what its pleasure was with reference to Dr. Mitchell's communication.

Mr. J. R. Godwin suggested that the letter be referred to a committee, with instructions to draft a report for the action of the members, and made a motion to that effect. The motion being seconded and unanimously adopted, the president appointed the following gentlemen: J. R. Godwin, of J. R. Godwin & Co.; H. M. Neely, of Brooks, Neely & Co.; Napoleon Hill, of Hill, Fontaine & Co.; J. W. Dillard, of Dillard, Coffin & Co., and R. F. Patterson, collector of internal revenue.

* * * * * * *

[This committee subsequently reported, through its chairman, Mr. Godwin, as follows:]

To the Officers and Members of the Memphis Cotton Exchange:

GENTLEMEN: Your committee, to which was referred the communication of Dr. R. W. Mitchell, asking "that the Exchange state, by resolution or otherwise, whether the inspection service has proved to be of sufficient value to the commercial interests of Memphis and the Mississippi Valley to warrant the National Board of Health in maintaining it during the next season," beg leave to offer the following preamble and resolutions for the consideration and action of the Exchange:

Whereas the Mississippi Valley has within the past seven years been afflicted with repeated epidemic visitations of yellow fever, which have caused an appalling loss of life, incalculable suffering, and severe, if not irreparable, injury to material interests; and

Whereas during the past critical period of 1880 there has been maintained by the National Board of Health an inspection service throughout the valley, from New Orleans to Cairo, which has preserved confidence, and so prevented panic and "shotgun quarantines," and consequent interruption of business and commercial intercourse; and

Whereas it is manifestly impracticable for the States or for communities, of themselves, to maintain this service, which, to be efficient, must be free from local influences and uniform in its operations beyond State boundaries; and

Whereas we believe such service to be essential to the protection of the public health of this region, and especially to the prevention of the introduction and spread of yellow fever; Therefore, be it

Resolved, That the Memphis Cotton Exchange recognizes in the National Board of Health an agency whose beneficent services to the whole Mississippi Valley cannot be overestimated, and which it is the duty of the general government to foster and maintain.

Resolved, That the inspection service of the said National Board of Health as conducted during the past season merits the unqualified approbation of every merchant, taxpayer, and citizen in the valley, to each and every one of whom it has been of direct personal benefit.

Resolved, That the National Board of Health be, and it hereby is, earnestly requested to continue said inspection service, and to establish and promote such other methods of sanitary work as may tend to redeem the Mississippi Valley from the scourge of epidemic diseases.

Resolved, That the secretary of the Exchange be, and he hereby is, directed to prepare for the signatures of members and others a suitable memorial to Congress setting forth the substance of this preamble and resolutions, and asking for such legislation as may be necessary to make said inspection service permanent, to enlarge its scope, and to increase its efficiency.

Resolved, That the Secretary be, and he hereby is, instructed to transmit a copy of the proceedings of this meeting to each Senator and Representative in Congress from the Mississippi Valley States, and to the various cotton exchanges, chambers of commerce, boards of trade, and kindred organizations in the same region.

J. R. GODWIN, *Chairman.*
H. M. NEELY.
NAPOLEON HILL.
JOHN W. DILLARD.
R. F. PATTERSON.

The report of the committee having been received, it was moved and seconded that the preamble and resolutions be adopted as expressing the views of the members of the Memphis Cotton Exchange. The motion was carried unanimously, and the secretary was instructed to take such action as might be necessary to inform the specified individuals and organizations and to secure concert of action throughout the valley.

DAVID P. HADDEN,
President.

SAM. M. GATES,
Secretary and Superintendent.

Similar action was taken by kindred bodies in Little Rock, Ark., Shreveport, La., Vicksburg, Miss., and elsewhere.

The following correspondence is also submitted:

NATIONAL BOARD OF HEALTH,
INSPECTION SERVICE, OFFICE OF THE DIRECTOR,
Memphis, Tenn., October 28, 1880.

DEAR SIR: Will you be good enough to favor me with your views as to the utility of the inspection service of the National Board of Health, stating whether, in your opinion, it has proved to be of sufficient value to commercial and railroad interests to warrant the Board in continuing it during another season?

I shall be largely guided by the judgment of yourself and other representative men in the valley in the recommendations which it is my duty to make to the Board in connection with the report of the operations of this service, which I am now about to submit.

Very respectfully,

R. W. MITCHELL,
Member National Board of Health and Director Inspection Service.

Maj. M. BURKE,
Superintendent Mississippi and Tennessee Railroad, Memphis, Tenn.

MISSISSIPPI AND TENNESSEE RAILROAD,
OFFICE OF THE SUPERINTENDENT,
Memphis, Tennessee, November 3, 1880.

SIR: Your letter of the 28th ultimo, asking whether, in my judgment, the inspection service of the National Board of Health has been of sufficient value to commercial and railroad interests to warrant its further continuance, was received while I was engaged in completing my annual report to the stockholders of the Mississippi and Tennessee Railroad. I have deferred answer until I could furnish some figures to sustain my opinion.

I knew, in a general way, as I suppose all railroad men south of Saint Louis and west of Chattanooga know, that the confidence felt through the Mississippi Valley in the supervision and certificate system of the National Board of Health had been of signal benefit in preventing panic and local quarantine on several occasions during the past summer, particularly in July last, when the Excelsior cases occurred in New Orleans, just about the time of the anniversary of the Memphis outbreak of yellow fever in 1879, and when every one in the Mississippi Valley was more or less apprehensive, and it would have been very easy to create a costly panic. At that time Grenada, the southern terminus of our road, and which suffered so severely in 1878, prepared at once to enforce a local quarantine, and would undoubtedly have done so but for the measures instituted by the National Board of Health. Quarantines are catching, and if Grenada had started one, the probability is that other places would have followed suit. The railroads know, to their cost, what such quarantines mean, and I believe it was the settled determination of some of the most important roads, in the event of their establishment as in 1878-'79, to run their engines into the yard, and not turn a wheel until the people had come to their senses.

Fortunately, no such emergency has arisen during the past year, and the following table and figures will show the difference in the results to this road:

Comparative statement of the business of the Mississippi and Tennessee Railroad for the years ending September 30, 1879 *and* 1880, *respectively.*

Cotton transportation.	1880.	1879.	Increase.
	Bales.	*Bales.*	
Shipments from local stations to Memphis	52, 919	49, 170	3, 749
Shipments from local stations to New Orleans	23, 292	13, 209	10, 083
Total local cotton	76, 211	62, 379	13, 832
Received at Memphis from line of Chicago, Saint Louis and New Orleans Railroad	1, 306	750	556
Forwarded from Memphis to New Orleans	95, 344	38, 879	56, 465
Total number bales transported	172, 861	102, 008	70, 853

It would be misleading to attribute all of this increase to any one cause, and it would be manifestly improper to compare 1879 with 1880 in order to determine the value of the inspection service, since in the former year Memphis was still closed by quarantine during the early part of the cotton-shipping season, and the injury to our business was due to this cause and to the yellow fever in the city. Excluding Memphis on this account, and comparing only the local stations which were not affected by these conditions, it will be seen that the increase of 1880 over 1879 is + 76 per cent., and a very large share of this increase is undoubtedly due to the general sense of confidence which people had come to feel in the inspection service in 1880, and which thus preserved intercourse and traffic from interruption in that year. The service was too incomplete and too novel in 1879 to inspire this confidence, and as a

consequence every town and village and railroad-crossing run an independent quarantine of its own, in the face of which it was almost impossible to run a railroad train.

This opinion is still further strengthened by comparisons of the passenger earnings and the freight earnings for the two years. Still excluding Memphis, for the reasons above given, the increase of our passenger earnings in 1880 over 1879 will be seen to amount to + 68 per cent. (See Table No. 3, Annual Report.) The freight earnings for local stations outside of Memphis nearly doubled in 1880 those of 1879, the increase being 97.7 per cent. (See Table No. 6, Annual Report.)

I do not know that anything which I could say would add to the value of the testimony of these figures. But I have no hesitation in asserting that I believe it to be the duty of the National Board of Health to continue its inspection service, not only next season, but every season, until the valley is no longer liable to be visited by yellow fever. This assertion, I think, expresses the opinion of every railroad manager with whom I am acquainted.

Very respectfully,

M. BURKE,
General Superintendent.

R. W. MITCHELL,
Director of Inspection Service, National Board of Health, Memphis, Tenn.

NATIONAL BOARD OF HEALTH—INSPECTION SERVICE,
OFFICE OF THE DIRECTOR,
Memphis, Tenn., October 28, 1880.

SIR: Before closing my final report of the river inspection service of the National Board of Health for the season of 1880, I would be glad to have an expression of opinion from you on the following points:

1. Has the service been of any advantage or benefit to you and the interests you represent? If so, please state, briefly, in what respect.

2. Is it desirable, simply for business considerations and aside from the health question, that the service be continued another year?

Very respectfully,

R. W. MITCHELL,
Member National Board of Health and Director Inspection Service.

Capt. AD. STORM,
Superintendent Memphis and Saint Louis Packet Company, Memphis, Tenn.

OFFICE OF SAINT LOUIS AND VICKSBURG ANCHOR LINE,
MEMPHIS AGENCY,
Memphis, November 1, 1880.

SIR: Your favor of the 28th October was duly received. In reply I would say that a continuation of the river inspection service, as conducted by you during the past summer, is highly desirable, because its operations preserve confidence along the river and prevent local quarantine orders, which have been the cause of serious losses, both to steamboatmen and shippers, in the past.

Such regulations as it is necessary to enforce for the protection of the public health, being uniform under your service, we find it easy to comply with them, since we know what is expected, and can govern ourselves accordingly.

Formerly we very often learned of the regulations of a town only when the boat arrived at it and was met with a board of health order forbidding her to put off freight or passengers.

It was a ruinous condition of affairs for all concerned, and I hope, in the interest of the line I represent, that your inspection service will be continued, in order to prevent a return to the old way.

Though there has been no yellow fever to speak of this year it would have been very easy to get up a panic, which would have shut out our boats from many places during the summer months. I know that Cairo and some other towns would have quarantined against us if it had not been for the inspection certificates of your National Board.

I think we only escaped a panic on account of the towboat Raven by your prompt and decided action in sending the Benner down to intercept her.

In what I have written I think I represent the sentiments of all those interested in steamboating on the Mississippi River. Hoping that you will continue your inspections in the future, I remain, very truly yours,

ADRIANCE STORM,
Superintendent.

DR. R. W. MITCHELL, *Memphis, Tenn.*

Col. J. C. Clarke, vice-president of the Cincinnati, Saint Louis and New Orleans and of the Illinois Central railroads, replied as follows:

CHICAGO, SAINT LOUIS AND NEW ORLEANS RAILROAD COMPANY,
OFFICE OF THE VICE-PRESIDENT AND GENERAL MANAGER,
New Orleans, November 10, 1880.

MY DEAR SIR: I do not hesitate to say that in my opinion the National Board of Health, through its efforts and organization, has rendered important benefits to the people of the Mississippi Valley by providing the means to arrest the spread of infectious and contagious diseases, and so preventing panic and unnecessary interruption to commercial intercourse. It would be a calamity to have New Orleans, Vicksburg, Memphis, and the whole Mississippi Valley deprived of the efficient aid and services of the National Board of Health, its inspection system, and information and recommendations concerning sanitary regulations.

Very truly yours,

J. C. CLARKE,
Vice-President and General Manager.

Dr. R. W. MITCHELL, *Memphis, Tenn.*

F. de Funiak, general manager of the Louisville and Nashville, and Nashville, Chatanooga and Saint Louis railway companies, hopes that "the Board will keep on with the good work it has engaged in."

D. W. C. Rowland, general superintendent of transportation of the Louisville and Nashville Railroad, writes: "My opinion was lately asked upon this subject, and I replied that I did not think it good to relax any work that was set in motion against the yellow fever, at least until we are a great deal further from the epidemic than now. We are all apt to forget these things and relax vigilance as soon as the immediate danger is past. I would by all means keep the inspection service alive."

J. T. Harahan, superintendent Memphis division Louisville and Nashville Railroad, says: "I am decidedly of the opinion that the work laid out and carried forward this year by the National Board of Health should not be stopped, but should by all means be continued. * * * As far as this road is concerned, the National Board rendered valuable assistance in keeping up communication with Memphis, and the inspection system was of great benefit to the commercial and railroad interests which this line serves."

John A. Grant, general superintendent of the Memphis and Charleston, writes: "My own opinion is that the inspection service should be continued, even if there are doubts as to its necessity, as it is certain that if there is an error it is on the right side."

Among other expressions is the following from representatives of the principal coal merchants and packet companies of Pittsburg, Pa.:

"The undersigned, owning and representing coal interests, steamboats, and towboats plying on the White, Arkansas, Ohio, and Mississippi Rivers, and whose business in former years has been seriously injured by yellow fever, consider the inspection service of the National Board of Health invaluable, and under the regulations of this year it has been so ably managed as to avoid all the trouble and delay of former years when local boards had control. We believe the service necessary for the health and prosperity of the Ohio and Mississippi valleys, and earnestly pray for a continuance of it."

Signed by A. J. McConnell, for Saint Louis and Huntington Packet Company; James Rees, Duquesne Engine Works; J. T. Stockdale, superintendent Pittsburgh and Cincinnati Line; R. C. Gray, Gray's Iron Line; John A. Wood & Son; G. J. Grammer, superintendent Evansville and Cairo Packet Company; O'Neill & Co.; W. J. A. Kennedy, secretary Cumberland Towboat Company; Joseph A. Stone, for Coal Valley Coal Company; W. H. Brown, by Harry Brown; Joseph Walton & Co.; Simpson, Horner & Sons.

From Vicksburg, Capt. E. C. Carroll writes: "I represent here three important lines of steamers, viz, the Saint Louis and Vicksburg Anchor line, the New Orleans Anchor line, and the Parisot line of Yazoo and Sunflower River boats, and think the service established by the National Board of Health has been of incalculable benefit to all. It seems to meet a serious want in properly caring for the sick and preventing excitement and alarm over suspicious cases. In a business point of view, its value and usefulness are obvious, and I heartily recommend that the service be continued."

Similar letters have been received from John N. Harbin, superintendent Memphis and Pine Bluff mail line; J. D. Randall, superintendent Memphis and Saint Francis River United States mail line; James O'Neal, superintendent New Orleans Anchor line, Saint Louis; James H. Pepper, master James Howard; H. W. Brolaski, master John B. Maude; E. C. Postal, master Hard Cash; J. C. Coghill, master Belle of Shreveport; Stack S. Lee, master James Lee; Thomas L. Davidson, master Centennial; J. W. Bryan, master Commonwealth; Alex. M. Halliday, master Paris C. Brown; George Malone, master Coahoma; Mark R. Cheek, master Dean Adams; Ed. Nowland, master Katie Hooper; J. C. McCord, master Gold Dust; Albert Stein, master Charles Morgan, and others.

From Saint Louis: John A. Scudder, president Anchor lines; H. Lowrey, president Saint Louis and New Orleans Transportation Company; Henry C. Haarstick, vice-president Mississippi Valley Transportation Company; John P. Keiser, superintendent Vicksburg Anchor line; James O'Neal, superintendent New Orleans Anchor line.

Following is the text of the memorial prepared and circulated by the Memphis Cotton Exchange:

MEMORIAL.

To the Senate and House of Representatives of the United States:

We, the subscribers, citizens of the United States, and residents of ——, in the county of ——, and State of ——, do respectfully represent, that

Whereas the Mississippi Valley has been repeatedly afflicted with visitations of epidemic yellow fever, which have not only caused great loss of life, bodily and mental suffering, and destruction of material interests in the region aforesaid, but have also injuriously affected the country at large, so that the evil is a national one, and as such comes within the purview of the national Congress; and

Whereas during the past dangerous season of 1880 there has been maintained by the National Board of Health an inspection service of sanitary supervision throughout the valley from New Orleans to Cairo, which operates to prevent the introduction and spread of epidemic, contagious and infectious diseases, and, during the past critical season, has preserved confidence and prevented panic and "shotgun quarantines," with their consequent interruption of business and commercial intercourse; and

Whereas it is manifestly impracticable for the States or for communities of themselves to maintain this service, which, to be efficient, must be free from local influences and uniform in its operations without regard to State boundaries; and

Whereas we believe such service to be essential to the protection of the public health of this region, and especially to the prevention of the introduction and spread of yellow fever:

Therefore we, your petitioners, do earnestly pray for such legislation as in the wisdom and discretion of your honorable body may be deemed necessary to make said inspection service permanent, to enlarge its scope, and to increase its efficiency.

This has been signed by the president of the Merchant's Exchange of Saint Louis, the officers of all the Saint Louis transportation companies, public officials and representative citizens of that city; by the officers of the Cotton Exchange and representative citizens of Memphis; by merchants, bankers, railroad and river men, and others of Cairo; by the officers and members of the Cotton Exchange and the mayor and other officials of Little Rock; by the governor and every State official of Arkansas; and by similar representative citizens in Vicksburg, Shreveport, and many other places.

The memorials signed in Memphis have already been forwarded to Congress with the following letter:

DEAR SIR: The accompanying memorials are the result of a meeting of the Memphis Cotton Exchange, held October 30, 1880, and a report of which will be found in the inclosed pamphlet. Similar memorials from Shreveport, Vicksburg, Natchez, and elsewhere will, I am informed, be forwarded from those places to other members of Congress. I take the liberty of sending these to you as the representative of a State and community directly and vitally interested in the subject-matter of the petition. From such acquaintance as I have with your public career, I believe you will willingly lend your influence and good offices to promote the object of the memorialists. Just what legislation may be needed in the premises it is not undertaken to say. Your position and opportunities will enable you to decide this. All that we, as citizens of the great valley, ask is that an agency which has preserved confidence and prevented needless interruption of business during the past year may be continued in the future. That this is asked as directly in the interest of New Orleans and Louisiana as of any other city or State in the valley, it is hardly necessary to say.

I am, sir, very respectfully,

DAVID P. HADDEN,
President Memphis Cotton Exchange.

Hon. RANDALL L. GIBSON, M. C.,
Washington, D. C.

In view of the action taken by the several bodies hereinbefore set forth, and the great service rendered to the commerce of the Mississippi Valley, I respectfully submit the following recommendations:

1. That the Mississippi River inspection service of the National Board of Health be continued—inspections to begin promptly on the 1st day of May, and to be maintained during the summer and autumn until there is no longer danger of an epidemic spread of yellow fever.

2. That the service be extended and made continuous, under one supervision, from Cairo, Ill., to the Gulf.

3. That a fully-equipped inspection station be established and maintained at a suitable point on the Mississippi below New Orleans, and as near the mouth of the river as practicable. Such station could, probably, be made legally operative only through the invitation and by the proper action of the Louisiana State board of health; but it is understood that such invitation and action are already contemplated, and that the Mississippi quarantine station of that board may be converted into a station of inspection only—infected ships not to be retained in the river, but to be sent to Ship Island for treatment. In the equipment of this station, therefore, there should be provided a powerful sea-going towboat, capable of handling any infected vessel and towing her to the Ship Island quarantine station. Failing the necessary action by the Louisiana State board, it is then recommended—

4. That a *service of observation* be maintained on the river between New Orleans and Port Eads by means of a suitable patrol-boat in charge of a vigilant inspector, whose duty it should be to promptly notify the National Board and the various State and municipal boards in the valley above New Orleans of threatened danger from infected vessels or other sources. For this service there is already sufficient legal authority in the action and attitude of the State and municipal boards of Mississippi, Tennessee, Arkansas, Kentucky, and Illinois.

5. That inspectors for duty in this service be hereafter appointed only after proper examination. Inspectors to be continued on reduced pay when not on active duty. (It is believed that desirable officers can be permanently secured if it were understood that the minimum rate of pay would be, say, $200 per month for six months of active service, and $100 per month when not on active duty.)

6. That substantial and suitably-equipped hospital-floats be provided for each station for the care and isolation of those suffering with infectious or contagious diseases, or suspected of being so affected.

7. That ready-made, portable frame huts or houses be provided for the shelter of the inspectors and employés at the stations where there are no suitable structures otherwise provided—this in order to preserve the health and working efficiency of the force.

8. That the sum of $75,000, or so much thereof as may be necessary, be appropriated for the maintenance of said service and for the purposes above set forth.

All of which is respectfully submitted.

R. W. MITCHELL,
Member National Board of Health.

Dr. T. J. TURNER,
Secretary National Board of Health, Washington, D. C.

INDEX.